ENVIRONMENTAL ASSESSMENT

Issuance of a Special Use Permit by the U.S. Fish and Wildlife Service for GX Technology's Gulf of Mexico LithoSpan Phase I 2D Seismic Survey within the McFaddin National Wildlife Refuge, Texas

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1.0 PURPOSE AND NEED FOR ACTION

GX Technology (GXT) proposes to conduct a two dimensional (2D) seismic survey (Gulf of Mexico LithoSpan Phase I) on a portion of the McFaddin National Wildlife Refuge (McFaddin NWR) in Jefferson County, Texas. The approximate 4.0 linear mile (21,144 feet) long proposed project area is located approximately 75 miles (mi) east-southeast of downtown Houston, Texas. The proposed project corridor is approximately 100 feet wide on either side of the proposed 2D line, encompassing approximately 96.97 acres, or 0.17%, of the total area within the McFaddin NWR. The proposed project is depicted in **Figure 1.**

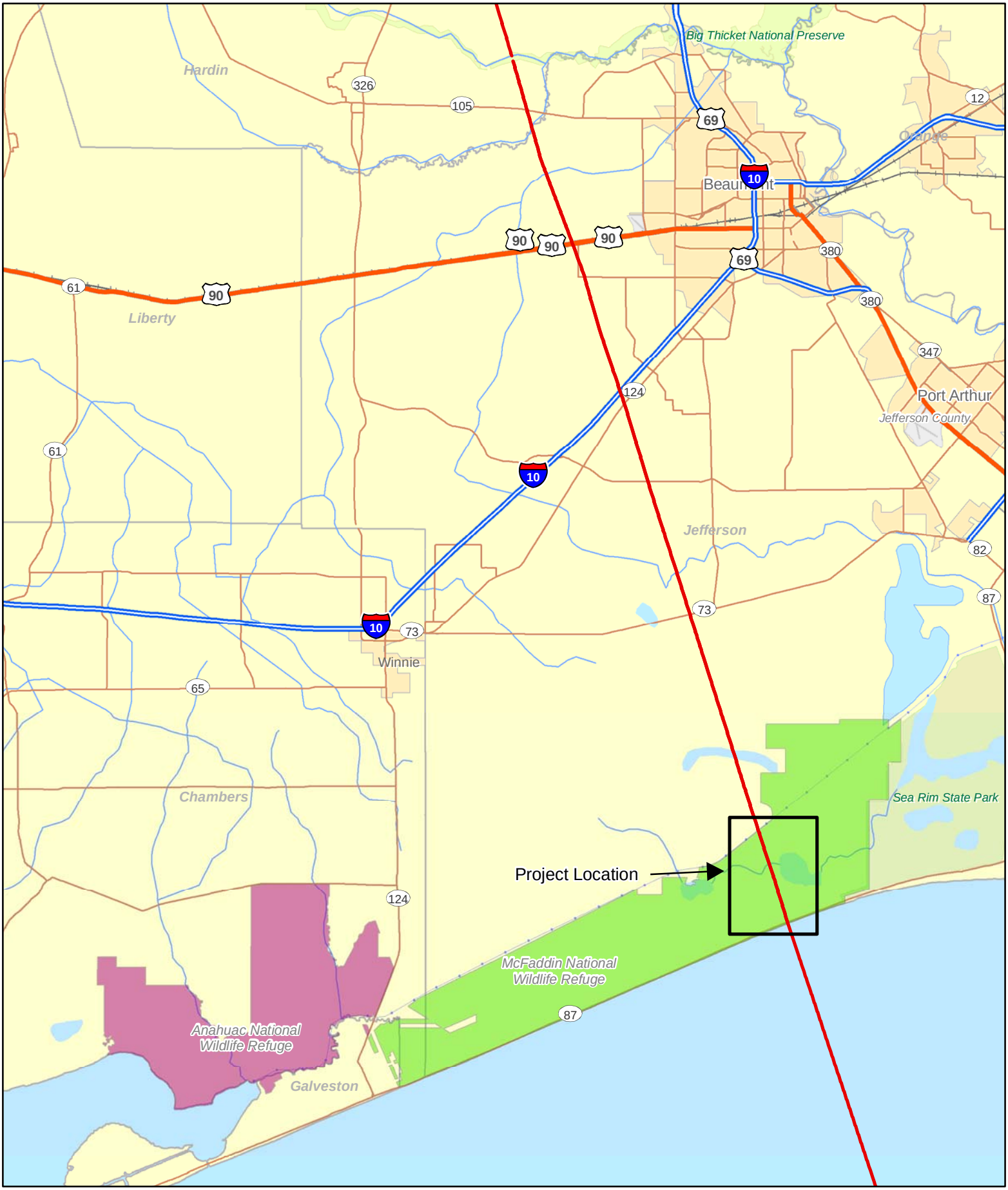
The Federal action considered within this Environmental Assessment (EA) is the issuance of a Special Use Permit (SUP) by the U.S. Fish and Wildlife Service (USFWS), of the U.S. Department of Interior (DOI), to access surface lands of the McFaddin NWR to conduct a 2D seismic survey necessary for evaluation of potential subsurface petroleum hydrocarbon reserves below the project area and adjacent lands.

1.1 INTRODUCTION AND BACKGROUND

The McFaddin NWR, a coastal refuge located in southeast Texas, is part of the Texas Chenier Plain National Wildlife Refuge Complex (Refuge Complex). The Refuge Complex contributes to the conservation of wildlife and their habitats in the Texas Gulf Coast Ecosystem. The individual NWRs in the Refuge Complex encompass a diversity of habitats: aquatic habitats (open water and near shore Gulf habitats), freshwater to saline marshes, riparian habitats, coastal woodlots, rice fields, native prairies, cheniers and coastal beach and dune habitats. These areas host a multitude of plant, invertebrate and vertebrate species including over 300 bird species, 75 species of freshwater fish, and 400 species of salt and brackish water fish and shellfish. The Refuge Complex protects quality habitats for migrating, wintering, and breeding waterfowl; shorebirds; and waterbirds, and provides strategic and crucial resting areas for neotropical migratory songbirds migrating across the Gulf of Mexico.

The primary authority in establishing the McFaddin NWR was the Migratory Bird Conservation Act (MBCA) of 1929 (16 U.S.C. 715d), "…for use as an inviolate sanctuary, and for any other management purposes, for migratory birds." The Refuge Complex is administered by the USFWS, as a unit of the National Wildlife Refuge System. Lands or certain interests in lands added to the Refuge Complex since their original establishment were also acquired under the authority of the MBCA, with the same establishment purpose. Lands have been added to the Refuge Complex under three additional authorities, with the following purposes:

> "… the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions…" 16 U.S.C. 3901(b), 100 Sta. 3583 (Emergency Wetlands Resources Act);



Legend

- Proposed GOM Lithospan Ph. I 2D Line
- McFaddin NWR

GOM Lithospan 2D Phase I

Figure 1: Project Area

GX Technology

Jefferson County, Texas

Map Datum: NAD 1927 UTM Z15N, Meter
Map Base: ESRI USA Base Map

N

1:510,024

Map Produced by
Dixie Environmental Services Co., LP
April 19, 2012

0 1 2 4 6 Miles

> "…suitable for—(1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species…" 16 U.S.C. 460K-1 (Refuge Recreation Act); and,
>
> "…for the conservation, maintenance, and management of wildlife, resources thereof, and its habitat thereon,…" 16 U.S.C. 661-667e (Fish and Wildlife Coordination Act).

The USFWS acquired all the lands comprising the McFaddin NWR subject to the exercise of privately-held mineral rights, which include rights to explore and develop oil, gas and other hydrocarbons. For example, the 1977 Environmental Assessment addressing the original establishment of McFaddin NWR stated that the USFWS "…proposes to acquire 54,500 acres (ac) of Texas gulf coast waterfowl wintering and breeding habitat, through the acquisition of private land in fee title (less any oil, gas, and mineral reservation)." Further, the EA stated "Continued mineral development would be permitted under U.S. Fish and Wildlife Service administration. The U.S. Fish and Wildlife Service would have the right to regulate access and surface use during exploration, drilling, development, transportation, and removal of minerals." The USFWS clearly stated its intent to acquire lands within the McFaddin NWR subject to already outstanding minerals interests and to allow the reservation of any minerals that the sellers owned. For each acquisition, the USFWS determined that acquiring the land subject to outstanding mineral interest and allowing the reservation of mineral interests by the seller was compatible with the purposes for which the lands were being acquired.

Texas State Law allows for subsurface mineral rights owners to explore and recover minerals found within their specific property. Texas property law allows the subsurface mineral owner to make reasonable and necessary use of the surface to explore for, develop, and produce its mineral interest. The legal concept is commonly described as the mineral estate being the dominant estate and the surface estate being the subordinate estate.

The USFWS manages seismic operations on NWR lands through the SUP process. When mineral owners/lessees request access to NWR lands, the USFWS reviews the planned operations and develops a set of stipulations necessary to provide NWR resource protection. The stipulations, which contain both requirements and limitations, are attached to and become part of the SUP as Special Conditions. The mineral owner or lessee is then offered the SUP conditioned on their acceptance of the stipulations contained in the SUP. The terms of the SUP and the proposed operation must comply with applicable sections of federal regulations dealing with minerals management on Refuge Complex. The specific Code of Federal Regulations (CFR) dealing with "Mineral Rights Reserved and Excepted" is 50 CFR 29.32, as follows in full:

> "*Persons holding mineral rights in wildlife refuge lands by reservation in the conveyance to the United States and persons holding mineral rights in such lands which rights vested prior to the acquisition of the lands by the United States shall, to the greatest extent practicable, conduct all exploration, development, and production operations in such a manner as to prevent damage, erosion, pollution, or contamination to the lands, waters, facilities, and vegetation of the area. So*

far as is practicable, such operations must also be conducted without interference with the operation of the refuge or disturbance to the wildlife thereon. Physical occupancy of the area must be kept to the minimum space compatible with the conduct of efficient mineral operations. Persons conducting mineral operations on refuge areas must comply with all applicable Federal and State laws and regulations for the protection of wildlife and the administration of the area. Oil field brine, slag, and all other waste and contaminating substances must be kept in the smallest practicable area, must be confined so as to prevent escape as a result of rains and high water or otherwise, and must be removed from the area as quickly as practicable in such a manner as to prevent contamination, pollution, damage, or injury to the lands, waters, facilities, or vegetation of the refuge or to wildlife. Structures and equipment must be removed from the area when the need for them has ended. Upon the cessation of operations the area shall be restored as nearly as possible to its condition prior to the commencement of operations. Nothing in this section shall be applied so as to contravene or nullify rights vested in holders of mineral interests on refuge lands."

GXT owns and/or leases the rights to explore for minerals underlying portions of the McFaddin NWR. GXT contacted the USFWS seeking surface access to the McFaddin NWR lands for the proposed 2D seismic survey.

Following discussions concerning the type of activities proposed, the USFWS proposed a set of stipulations, which would become Special Conditions of the SUP to provide surface access to McFaddin NWR. GXT requested a SUP for the proposed project within the McFaddin NWR for seismic operations. GXT agreed to conduct the operations pursuant to the stipulations contained in the SUP.

This Environmental Assessment (EA) addresses the issuance of a SUP to GXT, with stipulations attached, to conduct 2D seismic survey activities on the McFaddin NWR.

Issuance of a SUP to GXT for the proposed 2D seismic project is conditioned upon GXT providing satisfactory evidence to the USFWS documenting that they do in fact legally own or lease the rights to explore for minerals underlying the McFaddin NWR. Absent that, the USFWS would not issue a SUP and would deny surface access.

GXT has provided USFWS with documentation of the company's existing mineral rights within the McFaddin NWR. GXT is still pursuing mineral interests in all USFWS owned/managed lands within the Gulf of Mexico LithoSpan Phase I 2D project area (Project) for which mineral agreements have not yet been secured.

The entirety of USFWS owned/managed lands within the Project are addressed in this EA to allow for issuance of a SUP covering all areas in which GXT has the right to operate. If GXT is not able to obtain one hundred percent (%) of the mineral interest within the proposed project area upon issuance of a SUP by USFWS, the SUP will cover only those areas for which mineral interest has been provided.

1.2 DESCRIPTION OF THE PROPOSED FEDERAL ACTION

The proposed Federal action is the issuance of a SUP by the USFWS, DOI to govern the implementation of GXT's 2D seismic survey operations (Project) within the McFaddin NWR. The SUP contains a number of general provisions and stipulations aimed at protecting natural and cultural resources and minimizing conflicts with public uses and other USFWS management activities within the NWR.

The USFWS requires a SUP for those lands for which there are permitting requirements specified in the original conveyance documents. Consistent with agency policy, the USFWS has pursued voluntary permitting arrangements with GXT for conducting seismic survey operations on lands within the McFaddin NWR. The USFWS is proposing to issue a SUP to GXT to govern implementation of 2D seismic survey operations, including surveying, drilling, and recording operations. Through this permitting action, the USFWS is ensuring maximum protection of NWR habitats and fish and wildlife resources.

GXT has agreed to conduct the proposed 2D seismic survey project in full compliance with all stipulations of the USFWS SUP.

1.3 LEGAL MANDATES AND POLICY GUIDELINES

NWRs are guided by the mission and goals of the National Wildlife Refuge System (NWRS), the designated purpose of the NWR unit as described in establishing legislation or executive orders, USFWS laws and policy, and international treaties. Key concepts and guidance of the NWRS are covered in the NWR Administration Act of 1966, the Refuge Recreation Act of 1962, Title 50 of the Codes of Federal Regulations, the U.S. Fish and Wildlife Service Manual, and, most recently, through the Refuge System Improvement Act of 1997.

The Refuge System Improvement Act amends the Refuge Administration Act of 1966 by including a unifying mission for the Refuge System, a new process for determining compatible uses on NWRs, and a requirement that each NWR will be managed under a Comprehensive Conservation Plan. The Refuge Improvement Act states that wildlife conservation is the priority of NWRS lands and that the Secretary of the Interior shall "…ensure that the biological integrity, diversity, and environmental health of the System are maintained for the benefit of present and future generations of Americans…." Each NWR must be managed to fulfill the Refuge System mission and the specific purposes for which it was established. Additionally, this Act identifies the six wildlife-dependent recreational uses (hunting, fishing, wildlife observation and photography, and environmental education and interpretation) that are to be priority public uses of the Refuge System. These uses will receive enhanced consideration over other uses in planning and management.

1.4 USACE 404 PERMITTING

The U.S. Army Corps of Engineers (USACE) has been charged with the legal authority to protect the water resources of the United States, including vegetated wetlands, through Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act. The USACE

regulatory program supports the national policy of "no overall net loss" of wetlands through a process that ensures that any environmental impact on aquatic resources from construction projects requiring discharge of dredge or fill material, where applicable, will avoid, minimize, or mitigate for these unavoidable impacts to the "waters of the United States", including wetlands.

A desktop wetland determination of the proposed project area by GXT's consultant concluded that the survey activities will be performed in jurisdictional wetland areas and that Section 404 Clean Water Act (CWA) authorization from the USACE will be necessary. The majority of impacts associated with proposed operations are expected to be short-term, temporary, and localized to the source and receiver line locations in the form of flattened or killed vegetation as a result of equipment travel along the 2D line. These types of impacts generally recover in one to two growing seasons. A fraction of drill cuttings will remain on the ground surface at each source point location; however, the cuttings will be spread over each area in a manner consistent with pre-existing contours and will not have a permanent or significant impact to vegetation or wildlife. No net loss of wetlands is anticipated as a result of operations; therefore, no wetland mitigation is proposed for this project. Should permanent impacts result from operations, GXT would work with the USACE to fulfill mitigation requirements.

GXT coordinated with the USACE and USFWS to minimize impacts to wetland areas within the project area. GXT has obtained authorization from the USACE to conduct proposed operations in wetland areas under Nationwide Permit (NWP) 6. The USACE permit number is SWG-2012-00287 and was verified on July 30, 2012. A copy of this authorization is included in **Appendix D.**

2.0 ALTERNATIVES

2.1 ALTERNATIVES CONSIDERED IN DETAIL

2.1.1 Alternative A. Proposed Action. The USFWS Would Issue a SUP for the 2D Seismic Survey

Under Alternative A, the USFWS would issue a SUP to GXT governing all aspects of seismic survey activities. Under this alternative, the SUP would require GXT to complete seismic survey activities in compliance with a set of restrictions/stipulations developed to ensure maximum protection of natural and cultural resources within the McFaddin NWR, and minimize conflicts with public uses and other USFWS management activities. **The provisions and stipulations of the SUP are fully described in Section 2.2.7 of this EA.** Through the issuance of a SUP, and its subsequent administration to ensure strict adherence to its provisions and stipulations by GXT, the USFWS would actively manage the proposed activity to provide maximum protection to natural and cultural resources and public safety on the NWRs. The proposed action is the preferred alternative.

By agreeing to conduct the proposed project within the McFaddin NWR under all provisions of the USFWS SUP, GXT would agree to conduct all operations within the McFaddin NWR under stipulations aimed at protecting natural and cultural resources and minimizing conflicts with other uses of the McFaddin NWR, including public recreation, environmental education, and

scientific research. Under the Proposed Action, the overall environmental impacts of the project would be reduced. In addition, GXT would be responsible for restoration and/or mitigation of impacted habitats and infrastructure damages proven to be attributable to project activities.

2.1.2 Alternative B. No Action. The USFWS Would Not Issue a SUP for the 2D Seismic Survey

National Environmental Policy Act (NEPA) and Council for Environmental Quality (CEQ) regulations require the consideration of a "No Action Alternative" for the implementation of NEPA-regulated activities. Since the USFWS is considering taking a new action, issuance of a SUP to GXT for a 2D seismic survey within the McFaddin NWR, the NEPA "No Action Alternative" is the USFWS not acting at all. Therefore, the "No Action Alternative" addresses not issuing a SUP for the proposed project.

The "No Action Alternative" would occur under the following described set of circumstances. The USFWS would propose a SUP with attached stipulations to GXT; and, if GXT refused to accept the SUP and refused to agree to conduct operations pursuant to the stipulations, the USFWS would not issue a SUP. At that point, GXT could abandon its proposed project or could elect to proceed with the project relying on the underlying mineral interest owners' state property right to make reasonable and necessary use of the surface to explore for and develop its mineral interests. If GXT ultimately proceeded with project operations without a SUP, the USFWS would, of course, continue to enforce all of the applicable state and federal statutes and regulations.

Agreements between GXT and the leaseholders (lessors) require that GXT act as an agent of said lease holders so that the lessors may actively pursue exploration of the mineral resources of the lease within a specified time, or the agreement expires.

The "No Action Alternative" (i.e., denial of GXT's application for a SUP) could result in at least two possible consequences: (1) GXT, acting as an agent for the lessors, could legally conduct the proposed seismic survey without the SUP, and thus without benefit to the NWRs of the SUP and its stipulated environmental monitoring and mitigation requirements. It is possible that environmental impacts would be greater under this scenario, though GXT would be required to compensate the McFaddin NWR for surface damages that might result. Compensation would only be in response to damages that will have already occurred. (2) Lessors could drill wells to recover the mineral resources underlying the McFaddin NWR, in compliance with the terms of mineral leases governing these lands, based only on existing seismic and subsurface well data, without the benefit of GXT's specifically designed 2D seismic data that would result from the proposed seismic survey. This alternative could result in the drilling of unnecessary, non-productive wells and increased environmental impacts to the McFaddin NWR. In either scenario, the USFWS would continue to enforce all of the applicable state and federal statutes and regulations.

2.2 DESCRIPTION OF THE PROPOSED ACTION

GXT proposes to conduct a 2D seismic survey within all or portions of the McFaddin NWR

(**Figures 1 and 2**). The purpose of this survey is to provide ultra-long offset refraction measurements to develop an understanding of the deep crustal velocity structure to aid in the imaging of subsurface geology. This additional knowledge will allow GXT to effectively evaluate the potential for hydrocarbons (i.e. oil and gas) underlying the project area.

Seismic surveys are conducted by directing a seismic wave, generated by an energy source, into the subsurface of the earth and recording the reflection of that wave back on the earth's surface. The intensity and timing of the reflected wave are used to map the subsurface geologic features to the desired depth, and these maps are used to assess the potential for hydrocarbons to exist deep below the earth's surface.

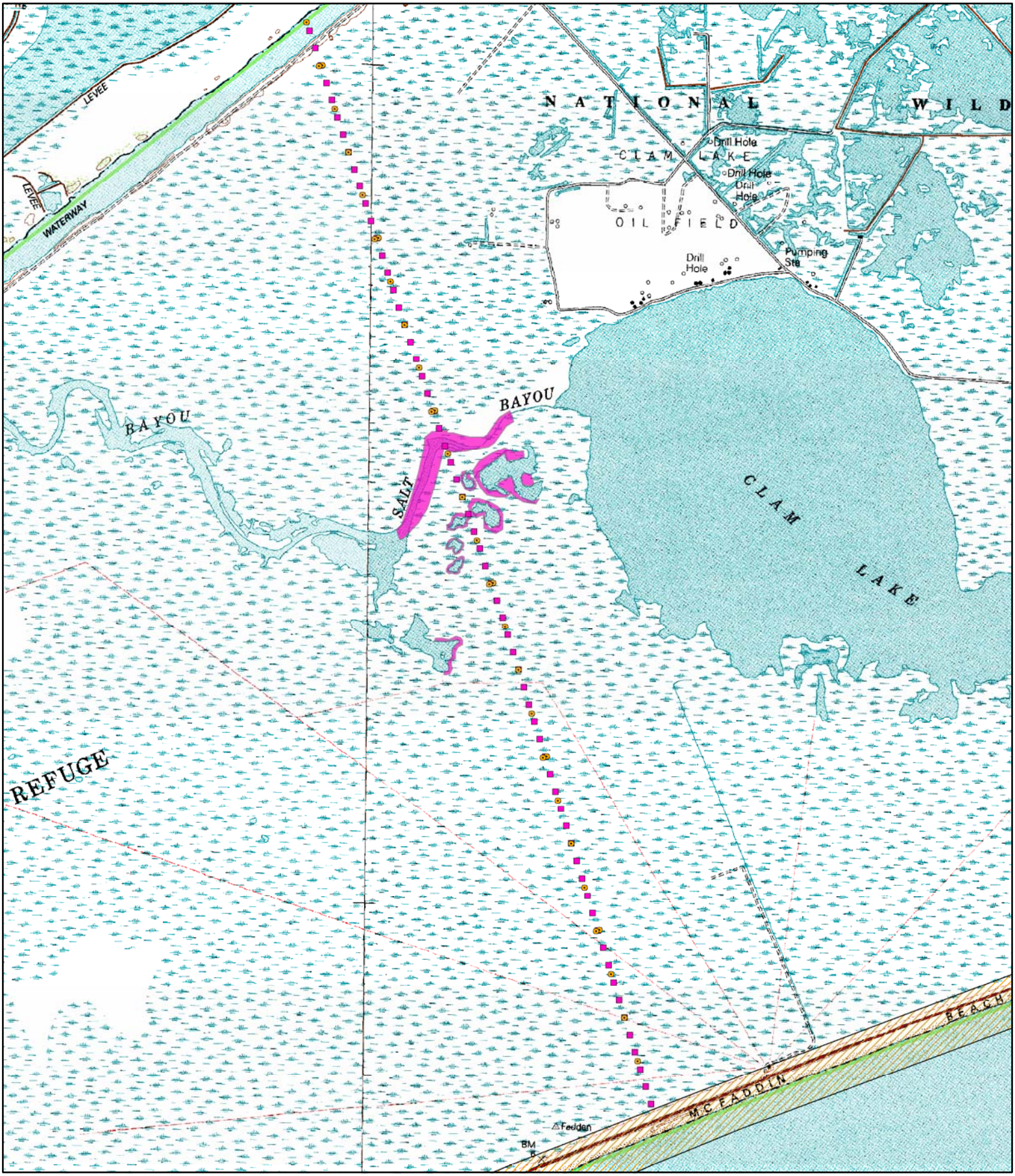
The primary energy source for this project within the McFaddin NWR will be explosive charges (e.g. *Pentolite*). The charge depth and configuration proposed consists of single, 24.4 meter (80 feet) deep holes (i.e. shot hole) drilled at intervals of 250 meters (762 feet) along each source line, alternating with two 30.5 meter deep (100 feet) holes drilled at intervals of 1,000 meters (3,280 feet). Each source location, or shot hole, within these areas will be loaded with a 2.49 kilogram (5.5 pounds) explosive charge and will be plugged in accordance with state regulations to prevent the mixing of surface and groundwater. Motion-sensing devices, known as receivers or geophones/hydrophones, will be spaced out along the 2D line at intervals of 100 meters (328 feet) (**Figure 2**).

It is estimated that approximately two months will be required to complete operations within the project area. However, there will not be a constant presence in any one area for the duration of the project. Operations would progress from south to north in a multiple wave-like manner as shot holes and receiver locations are surveyed and demarcated, shot holes are drilled, and sources are detonated and recorded in this order. Each of the three primary activities (i.e. surveying, drilling, and recording) will be temporary and of short duration at any given location within the project area.

2.2.1 Method of Operations

GXT and its contractors would use equipment that is well-suited for coastal marshes and wetlands. GXT has met with the Refuge Manager and understands that the company has a duty to minimize its effect on the resources of the Refuge and to maintain its occupancy to the minimum compatible with safe and efficient operations.

GXT is committed to the protection and conservation of the NWR coastal resources during the 2D seismic survey project. GXT and any contractors associated with project activities within the Refuge will meet with the NWR manager prior to initiation of surveying, drilling, and recording operations to ensure that all parties understand their responsibility for minimizing the project's effects to the NWR coastal resources.



Legend

- Pre-Plot Source Points
- Pre-Plot Receiver Points
- Terrestrial High Probability Area
- Archaeological Site 50 Meter Buffer
- McFaddin NWR Boundary

GOM Lithospan 2D Phase I

Figure 2: Proposed Pre-Plot Locations within McFaddin National Wildlife Refuge (NWR)

GX Technology

Jefferson County, Texas

Map Datum: NAD 1927 UTM Z15N, Meter
Map Base: 1:24K DRG from http://www.tnris.org

N

1:27,000

Map Produced by
Dixie Environmental Services Co., LP
April 19, 2012

0 550 1,100 2,200 3,300 Feet

Environmental monitors, approved by the NWR manager, would accompany/oversee crews working on the McFaddin NWR. Monitoring services would be provided by DESCO, and monitors would evaluate habitat conditions before the transport of equipment on and off the McFaddin NWR to help make least impact equipment determinations, observe each seismic crew during their operations on the McFaddin NWR to ensure compliance with SUP conditions, and document impacts to McFaddin NWR resources. Environmental monitors would report directly to the respective McFaddin NWR manager and GXT. Assessment of vegetation impacts within wetlands/marshes will include pre-project and post-project photo-documentation for reference use.

Operations associated with the proposed 2D survey are separated into five phases:

Phase 1: Planning and Permitting
Phase 2: Surveying
Phase 3: Drilling
Phase 4: Recording
Phase 5: Clean-up and Reclamation

A brief discussion of the activities associated with each phase of operations is presented in **Section 2.2.2** below.

2.2.2 Phases

2.2.2.1 Phase 1: Planning and Permitting
Planning and permitting precede field operations. Typical planning and permitting tasks include researching land/mineral ownership within the project area, securing surface and mineral agreements, coordinating with regulatory agencies and obtaining regulatory agency permits, analysis of alternatives, development of a plan of operations, selection of contractors and equipment, and other tasks necessary to facilitate field operations. Many of these tasks have been underway for some time. Most leases and/or options have been procured, and final regulatory approvals are being obtained.

2.2.2.2 Phase 2: Surveying
Field activities will commence with survey crews visibly marking the proposed locations of source holes and receiver points with survey lathes, cane poles, and flagging. Locating source and receiver points will be accomplished using global positioning system (GPS), inertial, and/or conventional surveying methods. Clearing of vegetation on land may be necessary to obtain line-of-sight for conventional surveying and/or allow for the safe passage of crews along the 2D seismic line. The cutting of brush, small trees (< 3 inches dbh at 12 inches aboveground), and branches would be accomplished through the use of machetes or brush hooks. Cutting will be limited to the minimum amount necessary to accomplish line-of-sight objectives upon Refuge Manager's approval. During surveying operations, crews will be present at any given point location for only minutes (<5 minutes/point) while marking the location. Survey crews typically travel through the project area only once, unless it is necessary to re-locate (offset) points or to re-establish point locations with flagging, markers, etc. Survey crews will offset source points for protection of structural and/or sensitive resources. GXT estimates that it will take less than

one week for hazard and access surveying to occur within the project area. Surveying of source and receiver points should take a total of one week within the McFaddin NWR.

2.2.2.3 Phase 3: Drilling

Once an appropriate number of source holes have been marked, drilling operations will begin. Drilling will be accomplished using highland buggies in dry, upland areas; airboats in open water or shallow/marsh areas that are inundated; and tracked, lightweight marsh buggies in dry marshes, as real-time conditions dictate and as approved by the McFaddin NWR manager. During the drilling phase of operations, drills would maneuver from source point to source point utilizing the route of least resistance to minimize impacts to vegetation. Additionally, equipment operators will minimize passes along the 2D line to only the number necessary to accomplish objectives and will avoid the duplication of paths within marsh environments by moving over a half boat or buggy length with each pass. Shrubs and herbaceous vegetation may be impacted in the paths of the drills; however, no trees would be cut/damaged. Points would be offset away from tree stands, if present, to the extent possible. No mechanized clearing will be conducted ahead of the drilling equipment.

A 4 inch (in) diameter hole will be vertically drilled at each source point location and a 5.5-pound explosive charge will be loaded to the bottom of the hole. Holes will be backfilled with as much of the cuttings as practicable and plugged with bentonite (natural clay) as nearly as possible to its condition prior to the commencement of operation, in accordance with standard industry practices and agency regulations for the prevention of the commingling of surface and groundwater. **Appendix D** provides a summary of RRC Rule 100 which discusses plugging of shot holes.

The use of water is required during the drilling of source points on land. However, the amount of water required at each source point is dependent on several variables such as the depth of the drill hole and soil texture. Water sources used during the drilling of source points must be approved by the McFaddin NWR manager and may be subject to TCEQ and/or Railroad Commission of Texas (RRC) permits. Drilling water will be transported in by low-ground-pressure vehicles from outside sources, or where approved, drawn from irrigation ditches, bayous, and similar natural watercourses.

Shot hole cap wire will be buried (when necessary) with a small magnet attached to the cap wire leads. The magnets, which are recovered and reused, will aid in locating shot holes with the use of a metal detector.

Drill crews would likely be present at each source point location for approximately 20 to 30 minutes, the average time that it takes to drill and plug a hole. Drill crews typically travel through the project area only once, unless it is necessary to re-drill source holes. Re-drills could be necessary as a result of bad or lost cap wire or because charges did not detonate properly during recording operations. Drilling should last less than one week within the McFaddin NWR.

The critical zones for seismic equipment passage include areas of sparse vegetative ground cover or areas with saturated soils. The McFaddin NWR manager and environmental monitors would be involved in identifying the critical zones to ensure the use of appropriate seismic equipment

for each situation. Minimal disturbance to soils and vegetation of the McFaddin NWR is a primary goal of the project.

Drill Equipment Options

Due to the unpredictability of conditions within the project area during the proposed time period of operations, several types of equipment have been considered for drilling and support within the McFaddin NWR. Water levels are highly variable, making it likely that a combination of different types of drilling equipment would be required to accomplish objectives. Each type of equipment that may be necessary is described below. **Table 1** provides a summary of the type of equipment proposed and the applicable habitat usages.

Highland Drill accompanied by a Water Buggy – The weight and size of this type of equipment limits its capabilities in sensitive areas. It is best suited for drier areas that can support its 18,000 pounds (lbs) (**Figure 3**). The rig is less maneuverable than smaller equipment due to the fact that it is 24 ft long, 8 ft wide, and 10.5 ft high. The drill is easily able to reach the desired depth of 80 or 150 ft using water and casing pipe. A water buggy, which transports several hundred gallons of water, accompanies the highland rig, enabling it to drill holes located away from water sources. Highland drills and water buggies can be equipped with 42 in wide terra tires (**Figure 4**), which more evenly distribute the weight of the rig and help to minimize impacts.

Pursuant to discussions with the McFaddin NWR, these drills (equipped with terra tires) will only be authorized on roads and other upland areas and in salty prairie habitat [gulf cordgrass (*Spartina spartinae*) dominated]. If the McFaddin NWR is experiencing above average rainfall and the salty prairie habitat is wet, these highland drills and buggies are not allowed. This rig is specifically prohibited from operating in marshes dominated by saltmeadow cordgrass (*Spartina patens*) and/or saltgrass (*Districhlis spicata*).

Multi-Engine Aluminum Airboat Drill – This drill (**Figure 5**) is capable of drilling to 150 ft depths with water and is best suited for shallow water habitats. The airboat travels easily over areas that hold even as little as a few inches of water. Generally, vegetation is only flattened in its path, and compaction is non-existent or minimal, depending on the depth of the water. The boat is 22 ft long, 14 ft wide, and 18 ft tall with the mast up (11 ft tall with the mast down). The weight of the airboat drill is distributed evenly over the unit, exerting less than 0.25 lb per square inch (psi) of pressure on the substrate.

Lightweight Aluminum Tracked Pontoon Drill – This drill is favorable to work within sensitive habitats because of its dimensions and weight distribution. The pontoon drill is approximately 27 ft 4 in long by 14 ft 8 in wide, and has a weight of approximately 25,000 lbs. This weight is distributed over two 25 ft. long by 4 ft. wide and 4 ft. wide pontoons with two track runners per pontoon. This results in creating an average exertion of 1.15 – 1.50 lbs per square foot (0.008 – 0.01 psi) on the substrate, making it ideal for saturated and semi-saturated environments. The dimensions of the equipment allow for more maneuverability than full size equipment such as traditional highland drills or aluminum track drills, which will minimize impacts to vegetation within the Refuges. The pontoon drill is pictured below in **Figure 6.**

Pursuant to discussions with the McFaddin NWR, these pontoon drills will be required on any sites not dominated by gulfcoast cordgrass. These pontoon drills provide buoyancy once wet areas are encountered, thus decreasing ground pressure and minimizing further damage. They also minimizes additional tracking across marshes

Figure 3: **Highland Rig and Water Buggy**

Figure 4: **Highland Rig and Water Buggy Equipped with Terra Tires**

Figure 5: Multi-Engine Airboat Drill

Figure 6: Lightweight Aluminum Tracked Pontoon Drill

Table 1: Specifications of Drilling Equipment Proposed for Use in Areas Managed by USFWS								
Equipment Type	**Weight (lb)**	**Height (ft)**	**Width (ft)**	**Length (ft)**	**Depth[1] (ft)**	**Drill Type**	**PSI**	**Suitable Habitats**
Highland Rig with terra-tires	18,000	10.5	8	24	40	Auger	5	Sparsely wooded or open dry areas.
					110	Flush		
					300	Flush		
Airboat Drill	8,000	8	14	22	180	Flush	<0.25	Areas holding water.
Lightweight Aluminum Tracked Pontoon Drill	25,000	8.33	14.67	27.33	110	Flush	<0.25	Open or wetland areas

[1] Depth to which equipment can drill under optimal conditions. N/A- Data not applicable or not available.
[2] Wet Auger drill, in which water is used in the drilling process.

2.2.2.4 Phase 4: Recording

Once an appropriate number of source holes have been drilled, recording operations will commence and progress as drilling continues. Recording operations within the McFaddin NWR would last approximately 7 to 14 days (1 to 2 weeks). Recording operations will be supported by helicopter to minimize impacts. Helicopters will lower cache bags containing equipment along the 2D line at the receiver location where crews on the ground will deploy the equipment.

Recording crew operations will be coordinated from staging areas set up at approved field locations on private lands. The locations of the staging areas may change during the project to facilitate more efficient operations. Staging areas serve as bases for equipment repair and helicopter operations and should ideally be located on highland sites to facilitate the movement of trucks and trailers. A coordinator's trailer, battery charging truck, equipment maintenance trailer, highboy transport trailers, and helicopter fuel trailer are typically located at the staging area(s) for the duration of recording operations. No staging areas will be located on Refuge lands. Data acquisition will be managed from the main instrumentation truck (recorder), which will be located at various road accessible sites around the survey area, as approved by the McFaddin NWR.

Recording equipment will consist of geophones/hydrophones, data recording boxes and batteries (set directly on the ground or floated in open water). The proposed recording equipment is anticipated to consist of a system of wireless digital sensors with rechargeable lithium batteries that last approximately 30 days. All recording equipment would be cableless. The proposed recording equipment has been successfully used for projects in sensitive environments and terrain, including lands managed by the Bureau of Land Management (Department of Interior) in northwestern Colorado. Batteries for the recording equipment are non-halogenated and constructed from flame-retardant materials, as well as shock/vibration resistant to meet demanding, outdoor applications in sensitive environments. Additionally, these batteries have been tested and determined to be in compliance with the vibration and pressure differential tests contained in 49 CFR § 173.1599(d).

Once enough equipment is laid out to complete recording, the recording crew will proceed with detonating shot holes. Crew members will travel between source point locations, connect a shooting pack to each electronic detonating wire (cap), and detonate each charge. The resulting reflected energy wave will be measured by the geophones/hydrophones and recorded.

Recording crews would move through the project area quickly, similar to survey crews, as they are only present at each receiver point location long enough to layout, troubleshoot, and/or remove equipment (<5 minutes). Recording crews will travel through the project area at least twice during operations to accomplish layout and removal of equipment. Additional trips may be required in any given area to repair and/or replace equipment and to download data from recording equipment.

Recording operations will be coordinated from approved field locations (more than one will be needed) suitable for the project. These locations may not necessarily occur on the McFaddin NWR. If a location becomes necessary within the boundaries of the McFaddin NWR, it would require approval by the McFaddin NWR Manager. The approved field location would serve as a home base to equipment and personnel associated with the proposed 2D project. An area will be designated for the setting up of a survey base antenna, and a location will be needed for a powder magazine and bentonite trailer, both potentially within the boundaries of the McFaddin NWR. These locations would also require approval from the McFaddin NWR Manager.

2.2.2.5 Phase 5: Clean-Up and Reclamation Operations

Clean-up will be conducted in conjunction with recording operations. After charges are detonated and recording is completed in each swath, all equipment, trash, and flagging will be picked up from the area and placed in cache bags for removal by crews, helicopter, or light-weight vehicles, as approved by the McFaddin NWR manager.

2.2.3 Safety and Offsets

GXT considers workplace safety and environmental awareness its top priority and an important component of project success. GXT will have a Health, Safety & Environmental (HSE) representative on site during all recording operations.

Infrastructure, such as roadways, utilities, and McFaddin NWR buildings and other structures will be avoided by sources and receivers, as necessary, per the McFaddin NWR manager and/or industry standards and best management practices. Particle motion testing will be completed in advance of operations in various areas throughout the project where structures occur to determine proper setbacks based on localized soil conditions. Avoidance locations and proper measures will be determined during civil survey activities as testing results dictate. Additionally, particle motion monitoring will be ongoing during recording operations to ensure protection of property and make setback adjustments as real-time conditions dictate.

Table 2 indicates the energy source operating distances commonly accepted by the geophysical industry and are consistent with operations in similar environments, as proposed.

Table 2: Energy Source Distance Chart in Feet

	Explosives Energy Source Charge size shown in pounds		
Object	**5 or Under**	**6 to 10**	**11 or Above**
Pipeline less than 6 inches diameter	100	140	190
Pipelines 6 to 12 inches diameter	150	215	280
Pipeline greater than 12 inches diameter	200	290	380
Telephone Line	40	56	76
Railroad track or main paved highways	150	215	280
Electric power line (Shot hole not to exceed 200 feet in depth)	TWO TIMES THE HOLE DEPTH		
Refuge water wells, water control structures, buildings, underground cistern, and all other objects not mentioned above.	300	430	560

Ground vibration monitoring will be conducted within the project area during operations. Offset distances would be adjusted accordingly for the protection of features based on monitoring efforts. The McFaddin NWR Manager may establish additional offsets for the protection of sensitive areas or wildlife.

2.2.4 Staging and Storage Areas

Additional storage areas may be needed for the storage of seismic equipment including, but not limited to, a trailer for storage of bentonite (hole plugging material). It is not anticipated that the storage of explosives would occur within the Refuge. In order for these additional storage areas to occur within the boundaries of the McFaddin NWR, they would have to be in accordance with the Bureau of Alcohol, Tobacco and Firearms regulations as approved by the McFaddin NWR Manager prior to establishment.

2.2.5 Equipment

Low-impact seismograph equipment will be utilized on the McFaddin NWR to ensure maximum protection of fish, wildlife, and their respective coastal habitats. The shot hole drilling equipment may include drill-mounted buggies, airboats, and light-weight tracked vehicles. Recording equipment will include recording instrumentation, geophones, hydrophones, batteries, GPS-based navigation systems, all-terrain vehicles (ATV), airboats, light-weight tracked vehicles, and a helicopter(s) for transport of equipment and personnel.

The specific equipment type used at any given location will be determined as the least intrusive for the habitat type and observed real-time conditions. Prior to use on the NWR, USFWS will determine suitable equipment for each habitat type present. In general:

- Lightweight single engine airboats will be required for transportation of personnel and drilling equipment in submerged lands and shallow water conditions.

- Lightweight aluminum tracked pontoon vehicles will be required for transportation of personnel and drilling equipment within emergent wetlands or marshes to minimize rutting. Non-pontoon vehicles are not permitted.

- Dependent upon soil and water conditions, drilling in saline prairies, grasslands, and other “highland” areas would occur using lightweight aluminum tracked buggies, traditional highland drilling buggies, or airboat drills. For general travel in highland operations, ATVs and/or helicopters will be used and operators will utilize existing natural and man-made travel roads (roads, trails, two tracks) to the extent possible to minimize environmental impact.

Whenever practicable, the layout, troubleshooting, and pick-up of receivers will be carried out on foot. A helicopter equipped with a long-line will be used to deploy and recover recording equipment to and from the 2D line. Shot hole drilling rigs mounted on buggies, airboats, or tracked pontoon vehicles will be used during the entire survey within the McFaddin NWR. Based on doubling the maximum width of the equipment and allowing for offsetting equipment tracks near the 2D line, a 100-foot corridor is required for operations (50 feet on either side of the line).

Additional crew vehicles will consist of utility trucks or vans for operations, logistics, and transportation to and from the crew accommodation site. Airboats and tracked vehicles will enter wetland areas; all other support vehicles will be restricted to designated roadways. Approval from the environmental monitor and the McFaddin NWR Manager will be requested, on a case-by-case basis, in the event that off-road access for support vehicles becomes necessary.

A generic list of equipment proposed for use during this project is listed below:

SURVEY CREW
2 single engine lightweight airboats; 5 pickup trucks; 2 lightweight aluminum tracked vehicles, possible Kubotas

DRILL CREW
1 airboat drill; 4 lightweight aluminum tracked pontoon drills; 2 single engine lightweight support airboats; 2 vehicles

RECORDING CREW
2 single engine lightweight airboats; 2 lightweight aluminum tracked pontoon vehicles; 5 vehicles; 2 ATVs; 1 helicopter

Descriptions of equipment that could be utilized to support surveying, drilling, and/or recording operations, which were not described in **Section 2.2.2.3** as drilling equipment options, are included below.

Single Engine Aluminum Airboat – This airboat is utilized for support in transporting personnel, supplies, and explosives to the multi-engine airboat drills. These vessels keep the heavier equipment from making multiple trips over fragile marshland, thus reducing the environmental impact of drilling operations. The single-engine airboats are 15 ft long, 8 ft wide, 7 ft tall, and weigh approximately 3,500 lbs (**Figure 7**).

Figure 7: Single Engine Support Airboat

2.2.6 Schedule

The proposed 2D seismic survey project is anticipated to begin as soon as authorization is granted by USFWS. There are approximately 34 source points and 63 receiver points within the McFaddin NWR. The project would require approximately 30 working days on the McFaddin NWR, and is projected to be completed prior to October 15, 2012, pending unanticipated delays or inclement weather as specified by the USFWS. Surveying of receiver and source locations would begin after authorization is received from the McFaddin NWR Manager. Drilling of shot holes would begin approximately 7 to 10 days after the start of receiver and source line surveying. Seismic recording would then begin after a sufficient number of shot holes have been drilled (predicted at 4 days). Cleanup and reclamation would be coordinated with the USFWS to avoid migrating waterfowl. Operations are expected to progress south to north across the McFaddin NWR. **Figure 8** provides a timeline for the proposed operations.

All seismic operations on the NWRs will be conducted between April 15 and October 15 to reduce disturbance impacts to migrating/wintering migratory birds including waterfowl, shorebirds, and wading birds and to avoid the peak nesting season for mottled ducks. GXT understands that an earlier completion date is preferable to reduce potential disturbance impacts to blue-winged teal and other early migrating species, and will strive to complete the survey at the earliest possible date.

2.2.7 Mitigation Measures

Under the SUP, several management and operational procedures will be required throughout GXT's seismic survey activities to eliminate avoidable impacts to natural and cultural resources and infrastructure on the McFaddin NWR and to control, reduce, and correct unavoidable adverse impacts.

These required management and operational procedures are defined through the provisions and stipulations, which are the Special Conditions of the SUP. Administration of the SUP will include active monitoring of all seismic operations to provide the McFaddin NWR Manager with high-quality current information throughout the course of the seismic operations and allow the McFaddin NWR Manager to modify, if necessary, the course of the operations to protect the resources of the McFaddin NWR. The SUP will also include marsh habitat monitoring criteria and aerial image protocol, as outlined in **Appendix C**.

The McFaddin NWR Manager, environmental monitor(s), and any third party observers, if required, will retain the right to "stop work" in any situation that imperils a threatened or endangered species or its habitat, causes significant harm to resources of the McFaddin NWR, threatens cultural or historic resources, or endangers public safety. Any sightings of cultural resources or artifacts or sightings of threatened or endangered species by employees, contractors, or subcontractors of GXT will be immediately reported to the McFaddin NWR Manager.

As per regulations specified in 50 CFR 29.32 regarding oil and gas exploration activities on USFWS lands, the following stipulations will apply:

- GXT will, to the greatest extent practicable, conduct all seismic operations in such a manner as to minimize damage, erosion, pollution or contamination to the lands, waters, facilities and vegetation of the area.

- So far as is practicable, seismic operations will be conducted without interference with the operation of the McFaddin NWR or disturbance to the wildlife thereon.

- The physical occupancy of the project area will be kept to the minimum space compatible with the conduct of efficient seismic operations.

- Upon the cessation of seismic operations, the project area will be restored as nearly as possible to its condition prior to the commencement of operations.

GXT will be responsible for any damage caused by its personnel or that of any contractors or subcontractors hired by GXT, and for restoring impacted areas as closely as possible to original conditions prior to the end of operations. GXT will be responsible for restoration of and/or mitigation for damages to McFaddin NWR habitats and repairing damages to McFaddin NWR facilities and infrastructure proven to be attributable to operations, including roads, cattle guards, parking areas, levees, fences, culverts, and water control structures. The USFWS will enforce all applicable Federal statutes and regulations, including all McFaddin NWR-specific regulations.

Figure 8

Timeline

	Duration	Start	Finish	10/1/2012	10/8/2012	10/15/2012	10/22/2012	10/29/2012
Commence 2D Survey in McFaddin NWR	0 days	10/1/2012	10/1/2012	●				
Surveying	2 days	10/1/2012	10/3/2012	●				
Drilling	7 days	10/4/2012	10/11/2012		●			
Recording	3 days	10/12/2012	10/15/2012		●	●		
Cleanup & Reclamation*	*	*	*					

* Coordinated with USFWS to avoid migratory waterfowl

Table 3 contains a list of mitigation measures that will be incorporated into operations for the protection of Refuge resources.

Table 3: General Provisions, Operations, and Stipulations Designed to Minimize Interference with Public Use and Impacts to Natural and Cultural Resources for a 2D Seismic Survey on the McFaddin NWR		
Number	**Mitigation Measures**	**Resource/Concern Protected**
1	Shifting of the seismic source or receiver locations and subsequent operations will be required to avoid active migratory bird nests, alligator nests, muskrat dens, wildlife concentrations, and other sensitive wildlife features.	• Fish and Wildlife • Species of Management Concern
2	Killing or harassing any wildlife on the McFaddin NWR is prohibited; this includes snakes, turtles, frogs, or other wildlife. Only the environmental monitor(s) and McFaddin NWR personnel will remove venomous snakes from work areas. Spotlighting of wildlife by seismic survey personnel is prohibited, and operations after official sunset are prohibited.	• Fish and Wildlife
3	Fishing by seismic survey personnel while on duty is prohibited.	• Fish and Wildlife
4	.Light weight aluminum marsh buggies (tracked vehicles) will be used for drilling in emergent wetlands, which are too dry for airboat use, and in salty prairie habitats whenever practical. Use of terra-tired drilling and water vehicles must be approved by the Refuge Manager, and these vehicles will only be used if water availability restricts use of lightweight tracked vehicles.	• Vegetation • Geology and Soils • Water Resources, Floodplains and Wetlands
5	Airboat drills will be used in shallow water habitats. The boundary between the tracked vehicle operations and the airboat operations will be determined with the input of the environmental monitor(s). Airboat drills may be used as the preferred drilling apparatus wherever conditions permit.	• Vegetation • Water Resources, Floodplains and Wetlands • Geology and Soils

Table 3: General Provisions, Operations, and Stipulations Designed to Minimize Interference with Public Use and Impacts to Natural and Cultural Resources for a 2D Seismic Survey on the McFaddin NWR		
Number	**Mitigation Measures**	**Resource/Concern Protected**
6	Equipment used to haul water to the drills must be consistent with the drilling vehicles used in a particular habitat. On-site determinations will be made by USFWS and the environmental monitor(s) at the time of drilling as to whether water will be hauled to the drills or will be obtained at the drilling sites by digging with a small bucket or backhoe. If holes are dug, they will be promptly refilled, leveled and repaired as near as practicable to their original condition. Wherever practicable, water available at the drill sites will be utilized, including laying hose and pumping from nearby water sources.	• Geology and Soils • Vegetation • Water Resources, Floodplains and Wetlands
7	Potential vegetation damage and soil compaction/rutting along shot and receiver locations will be reduced by: 1) restricting the number of vehicle and airboat passes along the 2D line to the minimum reasonably required. GXT will limit receiver line checks to the minimum practicable. Wherever practicable, laying and servicing receiver equipment will be accomplished by walking. Natural and man-made travel lanes (bayous and other waterways, roads and trails) will be utilized whenever practicable; 2) using helicopters to transport equipment to the 2D line within marshes to the maximum extent practicable; 3) using lightweight aluminum tracked vehicles and all-terrain vehicles (ATVs) where necessary in uplands and drier transitional sites; 4) minimizing turning by tracked vehicles (no locking tracks); 5) prohibiting the transportation of equipment by sleds; and 6) prohibiting all “cross-country travel” by mechanized vehicles.	• All resources/concerns
8	Damage to levees, ditches, and other waterway banks and shorelines will be minimized to the extent practicable by: 1) conducting drilling activities on one side of a waterway in a portion of the project area before proceeding to the opposite side, thereby minimizing crossings; 2) utilizing plywood, PVC pipes or other appropriate materials at crossing locations; and 3) avoiding lateral travel along banks and shorelines.	• Geology and Soils • Vegetation • Water Resources, Floodplains and Wetlands • Fish and Wildlife
9	All beach access will be limited to the McFaddin NWR Managers’ approved access point from which personnel will be transported via ATV to areas in which walking to work sites along the beach ridges will be possible.	• Fish and Wildlife • Visitor Use and Experience • Geology and Soils

Table 3: General Provisions, Operations, and Stipulations Designed to Minimize Interference with Public Use and Impacts to Natural and Cultural Resources for a 2D Seismic Survey on the McFaddin NWR		
Number	**Mitigation Measures**	**Resource/Concern Protected**
10	GXT will pressure-wash all vehicles and equipment prior to deployment on the McFaddin NWR to avoid introduction of foreign plants or animals. Boats, vehicles, and other equipment will be inspected by the environmental monitor(s) prior to entering the McFaddin NWR.	• Species of Management Concern • Vegetation • Wildlife
11	Work, including trouble-shooting operations, will be conducted only during daylight hours within the McFaddin NWR.	• Health and Human Safety
12	Boat launch sites, water crossings, and vehicle/boat travel lanes will be approved by the McFaddin NWR Manager following a coordinated field review with GXT.	• Health and Human Safety • Visitor Use and Experience
13	Areas such as boat launches and access points, if disturbed by seismic survey activities, will be restored according to USFWS specifications.	• Vegetation • Visitor Use and Experience
14	Sensitive habitats will be identified by Refuge representatives and avoided by shifting shot and receiver locations and subsequent operations.	• Species of Management Concern • Vegetation
15	Operations will be offset 1,000 ft from the high tide line on shore to protect beach/ridge vegetation.	• Species of Management Concern • Vegetation
16	All vegetation damage and soil compaction/rutting will be restored by GXT as nearly as practicable to its condition prior to commencement of seismic operations, or will be mitigated for as specified by the USFWS.	• Vegetation • Soils and Geology • Visitor Use and Experience • Wildlife
17	A file search will be performed, at GXT's expense, by an archaeologist to identify any known cultural sites. The archaeologist will also identify and map high probability areas within the project area, and map buffer zones around all known sites and high probability areas.	• Cultural Resources

Table 3: General Provisions, Operations, and Stipulations Designed to Minimize Interference with Public Use and Impacts to Natural and Cultural Resources for a 2D Seismic Survey on the McFaddin NWR		
Number	**Mitigation Measures**	**Resource/Concern Protected**
18	A cultural resource avoidance plan, including low impact methodology, will be prepared for the protection of cultural resources, and all stipulations and recommendations describing operations and avoidance measures around cultural/historical features will be adhered to.	• Cultural Resources
19	All cultural resources identified in the file search and all high probability areas will be mapped (with buffers) by the archaeologist prior to beginning seismic operations, and source points will be offset outside of these areas for their protection. No source points will be placed within 50 meters (m) of identified sites. No source points will be placed within high probability areas unless a cultural resources survey is completed in these areas and no sites are found at the source point location(s).	• Cultural Resources
20	The seismic survey will only use the low-impact seismic survey methodology specified in the cultural resources avoidance plan	• Cultural Resources
21	Any discovery of cultural artifacts or features during the course of the seismic survey will be promptly reported to the USFWS and Texas Historical Commission. The NWR Managers and the environmental monitor(s) will have "stop work" authority for any activity that may threaten a cultural artifact or feature.	• Cultural Resources
22	Each day during the September teal season, GXT will not begin work on the McFaddin NWR until 12:30 PM.	• Fish and Wildlife • Visitor Experience and Use
23	GXT will provide adequate signage to inform the public of the proposed seismic survey at specified locations. Signs advising the public of seismic activities, or signs addressing public safety, will be approved by the McFaddin NWR Manager before being posted.	• Human Health and Safety • Visitor Experience and Use
24	GXT will confine vehicle and equipment movements to the designated access routes at all times. While on the job site, GXT and/or its contractor/subcontractor will confine all activities to the designated work areas.	• All resources and concerns

Table 3: General Provisions, Operations, and Stipulations Designed to Minimize Interference with Public Use and Impacts to Natural and Cultural Resources for a 2D Seismic Survey on the McFaddin NWR		
Number	**Mitigation Measures**	**Resource/Concern Protected**
25	Laying out of source and receiver points along the 2D line corridor and subsequent operations will be completed in a manner that avoids USFWS monitoring and research projects, including vegetation monitoring transects, SET tables, water quality monitoring devices, weather stations, and other scientific equipment, if present.	• All resources and concerns
26	GXT will establish and identify to the USFWS a designated point of contact who will be available at all times while GXT is conducting survey operations for communication and coordination with the USFWS.	• All Resources and Concerns
27	All water control structures, wells, and water gauges, if present, will be avoided and buffered as required.	• Water Resources, Floodplains and Wetlands
28	The USFWS and GXT will cooperatively develop a Contingency Plan to cover the potential occurrence of project-related or other incidences of wildfire during the seismic survey. Survey crews will carry basic fire suppression equipment (shovels, fire extinguishers, etc.). Crews will report any occurrence of wildfire to McFaddin NWR management.	• All Resources and Concerns
29	Possession of firearms is prohibited by NWR regulations.	• Human Health and Safety • Wildlife • Visitor Experience and Use
30	In the event that any roads, trails, parking areas, levees, and other infrastructure are impacted by the seismic survey, these resources will be promptly repaired at GXT's expense. GXT will repair any damages caused by GXT or its subcontractor's use of NWR facilities.	• Human Health and Safety • Visitor Use and Experience
31	All fences (barbed and electric) breached by the seismic survey will be repaired at GXT's expense in a timely manner, and in a manner agreed upon by the NWR Manager. The electric fence along the Gulf of Mexico shoreline shall remain charged during operations.	• Human Health and Safety • Visitor Use and Experience

Table 3: General Provisions, Operations, and Stipulations Designed to Minimize Interference with Public Use and Impacts to Natural and Cultural Resources for a 2D Seismic Survey on the McFaddin NWR		
Number	**Mitigation Measures**	**Resource/Concern Protected**
32	Cattle grazing operations being conducted by cooperators under the McFaddin NWR SUP, which are impacted by seismic survey activities (for example: impacting infrastructure including gates and fences, cattle losses), will be compensated, in accordance with the fair market value of actual losses incurred. All NWR grazing permittees will be contacted by GXT and provided information on the seismic survey and its impact to them before any survey activities occur on the NWR.	• Public Use and Experience
33	GXT will be responsible for providing necessary security for equipment/supplies stored on the NWRs	• Other Concerns
34	The McFaddin NWR speed limit of 15 miles per hour (MPH) or as posted will be strictly enforced. Lower speed limits may be posted at any time as deemed necessary by the McFaddin NWR Manager.	• Visitor Experience and Use • Health and Human Safety • Wildlife
35	The USFWS will not be liable for accidents or injuries incurred by GXT's employees, contractors, or assigns during the seismic survey.	• Other resources/concerns
36	Explosives will be stored in secured locations outside of the Refuge in accordance with Bureau of Alcohol, Tobacco, and Firearms regulations.	• Health and Human Safety
37	Field oil or fluid changes will be permitted on the McFaddin NWR in selected areas determined by the McFaddin NWR Manager. Any spilled oil will require prompt cleanup. Therefore, oil absorbent pads will be required on site at all times as a precautionary measure.	• All Resources and Concerns
38	While on the McFaddin NWR, all seismic equipment will be required to carry fully supplied, industry standard, spill kits	• All Resources and Concerns
39	GXT will provide the McFaddin NWR Manager with proof of sudden and accidental pollution insurance or post a bond prior to the initiation of the seismic survey.	• All Resources and Concerns

Table 3: General Provisions, Operations, and Stipulations Designed to Minimize Interference with Public Use and Impacts to Natural and Cultural Resources for a 2D Seismic Survey on the McFaddin NWR		
Number	**Mitigation Measures**	**Resource/Concern Protected**
40	All cans, bottles, paper, and other trash generated by the seismic crews will be removed from the McFaddin NWR daily or placed in designated trash receptacles. Trash receptacles must be emptied and trash removed from the McFaddin NWR on an as-needed basis.	• Visitor Use and Experience
41	All equipment and debris incidental to the survey, such as flagging, wires, poles, etc., will be removed following the cessation of activities within each swath.	• Visitor Use and Experience
42	GXT will advise the McFaddin NWR Manager at least 72 hours in advance of the initial survey activities and shall coordinate all activities during the seismic survey on the McFaddin NWR with the McFaddin NWR Manager or designated personnel	• All Resources and Concerns
43	The McFaddin NWR Manager will be provided with daily progress reports; up-to-date detailed maps providing project progression, as is available, to field operation managers and promptly after survey completion; and, provide detailed maps showing the exact final locations of all shot holes and receiver locations.	• All Resources and Concerns
44	GXT will provide the USFWS with aerial photographs and monitoring reports of the area surveyed within the McFaddin NWR (Appendix C).	• All Resources and Concerns
45	All applicable Federal and State regulations, including all McFaddin NWR-specific regulations, whether or not specified in the SUP, shall be enforced and adhered to by all seismic personnel at all times, except where explicitly exempted by the McFaddin NWR Manager. Seismic personnel shall comply with all applicable ordinances, laws, decrees, statutes, rules, and regulations of all Federal and State entities.	• All Resources and Concerns
46	The USFWS can add to or modify stipulations of the SUP during the seismic survey should additional or modified stipulations be needed to protect NWR resources or public safety.	• All Resources and Concerns
47	Dates given in this document for land use activities such as hunting, grazing, road construction and maintenance, and habitat restoration are specific to the 2011-2012 year, and are subject to change in 2013.	• All Resources and Concerns
48	GXT will furnish seismic locks for gate access by crew personnel.	• All Resources and Concerns

Table 3: General Provisions, Operations, and Stipulations Designed to Minimize Interference with Public Use and Impacts to Natural and Cultural Resources for a 2D Seismic Survey on the McFaddin NWR		
Number	**Mitigation Measures**	**Resource/Concern Protected**
49	All crew personnel vehicles will display a copy of the SUP at all times. Each crew leader will also carry a copy of the SUP with them at all times.	• All Resources and Concerns
50	GXT will submit the monitoring reports detailing the results from the pre- and post- GIS analysis (Appendix C).	• Water Resources, Floodplains and Wetlands
51	GXT will provide and display signs at NWR day use areas and trails to inform the public of their activities. Visitors will be notified, via signage and distribution of information, of the likelihood of helicopter operations being conducted throughout the operations area. Appropriate measures will be employed to reduce potential conflicts between seismic operations and the general public. GXT will provide additional information to any interested member of the public, and will educate the McFaddin NWR staff on the operations.	• Human Health and Safety • Visitor Use and Experience
52	GXT will not detonate source points within 200 ft of any Refuge visitor and/or member of the public. Two hundred feet is well over the industry-accepted safe distance for individuals from a source point. Crewmembers will ensure that there are no visitors in the vicinity of the source point being detonated.	• Human Health and Safety • Visitor Use and Experience

With incorporation of the general provisions, operations, and stipulations included in **Table 3**, impacts to Refuge resources, including wetlands, are expected to be minimal and temporary in nature. Should any permanent or cumulative impacts to wetlands occur, GXT will be responsible for compensating for those impacts at a minimum 2:1 ratio.

2.2.8 Monitoring

Non-service Refuge representatives will be present during each phase of operations to identify sensitive species/resources for avoidance and assist crews with least impact routes, equipment choices, and field methodology. These individuals will also ensure compliance with permit stipulations and document impacts to Refuge resources. The non-service Refuge representatives will work closely with the seismic crews and Refuge representatives to help minimize impacts while accomplishing project objectives in an efficient manner.

All non-service Refuge representatives or environmental monitors will be hired with prior approval from the McFaddin NWR Manager and will report directly to the McFaddin NWR Manager. The number of monitors on site at any given time will vary depending on the monitors' ability to access each of the crews. If the crews are working in close proximity to each other, it may be possible for one monitor to cover multiple crews; however, if travel time

between crews prohibits effective monitoring efforts, one monitor may be required for each crew. The decision on the required number of environmental monitors will be made by the McFaddin NWR Manager and the environmental monitors upon consultation with GXT. Monitoring services will be provided by DESCO and/or other monitoring services that have been approved by the McFaddin NWR Manager.

As equipment is removed from an area, a complete evaluation of the area's conditions will be made by GXT, with the assistance of the environmental monitor(s) and McFaddin NWR personnel, to determine if additional clean-up or remediation is necessary.

2.2.9 Operators and Lessors

GXT is the operator and lessor with respect to the proposed action. GXT is the holder of mineral leases underlying the project area. Documentation of lease option agreements executed to date has been provided to and approved by the USFWS.

2.2.10 Lease Agreement Authorization

GXT will comply with applicable sections of federal regulations in 50 CFR dealing with mineral management on federal wildlife refuges. Specifically, this seismic survey has been developed to satisfy the following provisions:

> 50 CFR 29.32 "Mineral rights reserved and excepted" governing mineral operations on refuge states "Persons holding mineral rights in wildlife refuge lands…(1) shall, to the extent practical, conduct all exploration, development, and production operations in such a manner as to prevent damage, erosion, pollution, or contamination to the lands, waters, facilities and vegetation of the area. (2) So far as is practicable, such operations must also be conducted without interference with the operation of the refuge or disturbance to the wildlife thereon. (3) Physical occupancy of the area must be kept to the minimum space compatible with the conduct of efficient mineral operations… (4) Upon the cessation of operations the area shall be restored as nearly as possible to its condition prior to the commencement of operations…"

2.3 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM ANALYSIS

The proposed seismic survey project is described in **Sections 1.0** and **2.0**. Briefly, the proposed project calls for a 2D seismic survey covering approximately 4.0 linear miles within the McFaddin NWR (**Figure 1**). The seismic survey within the McFaddin NWR will be acquired by drilling a series of shot holes, loading the holes with 5.5 lb explosive charges, detonating the shots one at a time, and recording the resultant reflected energy wave with geophones or hydrophones. As the 2D project is a single line/linear project, the progression of explosive detonation and recording would occur from a south to north direction within the McFaddin NWR.

Several alternatives for accomplishing project objectives were considered during the development of the Proposed Action, each of which addressed one or more of the issues

identified during the scoping process. Descriptions of each of the alternatives, as well as the reason(s) that each was eliminated from detailed analysis, are included in the following paragraphs.

2.3.1 Alternative Areas and Change of Area of Operations

Because the project area is defined by the area in which GXT owns the rights to explore for mineral resources, there is no alternative area for the proposed action. The area of operations and the actual layout of shot and receiver locations and subsequent operations along the 2D line will be modified to the maximum extent practicable in order to avoid sensitive habitat, wildlife, and cultural resource features within the McFaddin NWR.

2.3.2 Alternative Timeframes and Direction of Operations

The proposed project will be shot as a continuous operation and takes in sea turtle foraging habitat within the Gulf of Mexico, adjacent and outside of the McFaddin NWR boundary. Sea turtle nesting habitat, as well as potential wintering habitat for the piping plover have been avoided by the proposed project within the McFaddin NWR boundary, by having no source points located within 660 feet landward and 1,000 feet seaward of the shoreline vegetation line. The project area does not occur within designated critical habitat for the piping plover; however piping plovers have been documented within the McFaddin NWR.

GXT is undergoing Section 7 Endangered Species Act (ESA) consultation as part of the USACE Nationwide Permitting (NWP) process to address potential project impacts on threatened and endangered species. Based on the time necessary to complete the USACE permitting process, including ESA consultation, GXT estimates that the USACE NWP for the proposed project would be issued on or around August 2012.

Project timeframes and the direction in which operations would progress were evaluated in order to determine the parameters that would allow for the least potential for impacts to biological resources while accomplishing project objectives. McFaddin NWR stipulations prohibit activity from October 15 through April 15. It is not possible to limit operations to any given season; however, with operations in the Gulf of Mexico anticipated to begin in October 2012, by the time the project reaches the McFaddin NWR, the likelihood of sea turtles being affected near the beach boundary of McFaddin NWR would be considerably less. Operations within the McFaddin NWR would be within the window of time to prevent potential impacts to migratory birds.

2.3.3 Alternative Operational Methods

The USFWS and GXT have considered alternatives in operational methods including: 1) alternative energy sources; 2) the use of existing seismic data; 3) “cable-only” alternative; 4) alternative shothole depth; and 5) alternative shothole spacing. These alternatives, and the reasoning behind selecting the proposed operational design, which will be incorporated within provisions and stipulations of the SUP, are presented below.

2.3.3.1 Alternative Energy Sources

As discussed in **Section 2**, 5.5 lb explosive charges will be used as the energy source within the NWRs. An alternative source of energy for geophysical exploration is the use of land vibrators. Land vibrators require heavy, truck-mounted equipment that require solid ground and road access. Attempting to use these types of vehicles would result in more tracks, rutting damage, and destruction of vegetation than tracked drill buggies and airboats. It would not be feasible to transport these heavy pieces of equipment within the McFaddin NWR.

2.3.3.2 Existing Seismic Data

Available seismic data for the project area has been studied by GXT. While existing data has been valuable in general interpretation of the subsurface, the data does not adequately cover GXT's area of interest and was not designed to image the subsurface formations targeted by GXT. The data provided by GXT's proposed 2D seismic survey will minimize the impacts associated with future oil and gas development by pinpointing well locations and limiting the infrastructure needed to support multiple wells in a single area.

Utilizing existing data was not a feasible alternative; as it did not provide the coverage and/or data quality necessary for GXT to accurately image their objectives.

2.3.3.3 "Cable-Only" Alternative

Conducting all or a greater part of the 2D survey as a "cable-only" operation was considered as an alternative. Under this alternative, operations within the McFaddin NWR would consist of only surveying activities, and equipment layout, pickup, and troubleshooting. This method would eliminate the use of drilling equipment in the McFaddin NWR, and minimize impacts on Refuge resources, namely vegetation, soils, and natural soundscapes.

This alternative was not considered technically feasible, as it would leave a gap in the data set being collected as a result of the operations. If no source holes were drilled within the McFaddin NWR, GXT would not be able to acquire an accurate image of the subsurface underlying that area; therefore, this alternative would not accomplish GXT's objectives or allow the company to fully capitalize on their mineral interests in the area. For the above reasons, it was eliminated from analysis.

2.3.3.4 Alternative Shothole Depth

Alternatives to shothole depth and spacing were assessed during the planning phases of this project. Due to the nature of seismic recording, more shotholes would be required at shallower depths and fewer shotholes would be required at greater depths. In order to determine the best depth to place the charges, three things were considered: safety, minimization of impacts, and data quality.

The number of shotholes drilled at shallow depths (approximately 10 ft) would need to be three to four times that of holes drilled to the proposed depth of 80 ft in order to obtain similar data. An increase in the number of shotholes would result in greater disturbance during the drilling and recording phases of the survey. In addition to the disturbance directly resulting from the drilling of a greater number of holes, there is an increased risk of experiencing a "blowout," during which substrate/media is expelled from the shothole when the charge is detonated. Such

an event is considered to be a safety hazard and can result in greater impacts at the surface surrounding the hole.

Shotholes drilled at greater depths would likely result in fewer blowouts, thereby minimizing impacts. The most desirable shothole depths for the project, based on review of existing geologic information, is 80 and 150 ft; however, GXT has agreed to limit the shothole depth to 80 and 100 feet to address concerns raised by the McFaddin NWR and the RRC during the planning process. At these depths, the media is mostly clay, which is considered an efficient energy conductor and would provide better seismic data retrieval. Similarly, charges detonated at these depths would provide the data sufficient to image the subsurface features within the geologic formations from the surface to the center of the earth.

The 80-ft shothole depth proposed for the survey was selected due to the fact that it would reduce the risk of blowouts, minimize surface disturbance, address FWS and RRC concerns, and provide the most accurate data on the subsurface features of the area.

2.3.3.5 Alternative Shothole Spacing

The placement of shotholes proposed for the survey (250 meters, 762 ft) is synonymous with today's industry standards for 2D seismic surveys. Shotholes placed at distances greater than 762 ft apart would not provide sufficient data in the area, and shotholes placed at distances less than 762 ft apart would increase impacts. The 762 ft spacing proposed reflects GXT's ideal project design; however, points can be offset from these locations, within reason, and still allow for the collection of accurate data. GXT would offset shothole locations for the protection of sensitive species/resources in accordance with McFaddin NWR requirements.

2.4 COMPARISON OF ALTERNATIVES

Table 4 identifies and compares the Proposed Action and the No Action alternatives as a means of responding to the issues raised by USFWS managers and/or the public. These alternatives were summarized based on how they accomplish both Refuge and project objectives.

Table 4: Extent that Each Alternative Meets Objectives		
Objectives	**Does Alternative A: Proposed Action meet objective?**	**Does Alternative B: No Action meet objective?**
Avoid, minimize, or mitigate impacts on resources and values, visitor use and experience, and human health and safety within the Refuges.	**Yes** The 2D seismic survey would be conducted within the Refuge with the application of mitigation measures designed to avoid and minimize impacts to Refuge resources in accordance with a SUP.	**No** Impacts would not be avoided or minimized, as the project would not be conducted under a SUP and the client would not be required to adhere to restrictions designed to protect Refuge resources.

Table 4: Extent that Each Alternative Meets Objectives		
Objectives	**Does Alternative A: Proposed Action meet objective?**	**Does Alternative B: No Action meet objective?**
Provide GXT, as the lessee of nonfederal oil and gas mineral interests, reasonable access to conduct a seismic survey.	**Yes** GXT would be allowed to accomplish their objectives under the guidance of a SUP, while minimizing impacts to the environment.	**Yes** GXT would conduct the 2D seismic survey on Refuge lands with no restrictions on access.
Preserve, restore, and enhance diverse habitats to provide favorable conditions for migratory and native wildlife species.	**Yes** Impacts to habitat would be short-term and minimal. USFWS management of the operations would, through the issuance of the SUP and monitoring, ensure strict compliance to its provisions and numerous stipulations designed to protect vegetation, soil, and water resources.	**No** Overall damage to vegetation, soils, and aquatic habitats would be increased. Refuge management would not be consulted and would have no input into how activities would be conducted in sensitive vegetative habitats.
Promote and protect native and migratory wildlife populations on the Refuges to contribute to the purpose for which it was established and to the mission of the National Wildlife Refuge System.	**Yes** The proposed action incorporates measures that would prevent or minimize effects to fish and wildlife populations and their habitat from most impacts.	**No** There would be no stipulations restricting hunting, fishing, harassment or destruction of wildlife, destruction of nests or dens, or other protections offered through a SUP.
Provide opportunities for safe, quality, compatible, wildlife-dependent public use and recreation, which includes hunting, fishing, environmental education, interpretation, wildlife observation, and photography.	**Yes** GXT would work with Refuge representatives to minimize interference with Refuge management actions, educational opportunities, and other Refuge uses. Impacts on public use are expected to be minimal.	**No** Increased impacts to infrastructure such as roads and fences are expected, and increased conflicts with Refuge public waterfowl hunting and refuge management programs would occur as a consequence of the lack of issuance of a SUP.

Table 4: Extent that Each Alternative Meets Objectives		
Objectives	**Does Alternative A: Proposed Action meet objective?**	**Does Alternative B: No Action meet objective?**
Protect Refuge cultural resources in accordance with Federal and state historic preservation legislation and regulations	**Yes** Under this alternative, historic and archeological sites would be protected, as operations would be offset from all known sites. If a site of potential historical, archaeological or cultural interest is encountered during the seismic survey, work would be stopped in the immediate area and the appropriate authorities notified.	**Yes** Without daily oversight of seismic program activities provided by the USFWS and environmental monitors, there would be a lower level of protection for known sites and high probability areas as well as less timely reporting and protection of any inadvertent discoveries of cultural or historic artifacts or other resources.

3.0 DESCRIPTION OF THE AFFECTED ENVIRONMENT

3.1 INTRODUCTION

The McFaddin NWR is a coastal refuge located in southeast Texas, approximately 75 mi east-southeast of Houston adjacent to the Gulf of Mexico. The McFaddin NWR is part of the Texas Chenier Plain National Wildlife Refuge Complex, which also includes the Texas Point NWR, Anahuac NWR and Moody NWR. All activities proposed are solely within the McFaddin NWR. The Refuge Complex offers a wide variety of coastal wetland and upland habitats suitable for a diversity of wildlife species unique to the Texas coast such as coastal wetlands, coastal prairies, croplands, bayous, wooded riparian zones, and small coastal woodlots. "This complex of refuges includes some of the most important bird habitat on the Gulf Coast," (Gulf Coast Bird Observatory, 2011). These NWRs were established under the authority of the MBCA and are managed by the USFWS, DOI, as units of the NWRS.

The project area encompasses 48.48 ac of the McFaddin NWR. The McFaddin NWR was established in 1980, under authority of the MBCA. Its boundary was expanded in 1995, 1996, and 2005, also under authority of the MBCA. Currently, the Refuge administers a total of 58,355.59 ac.

The coastal marshes of the McFaddin NWR are home to a vast array of wildlife species. Common wildlife species present within the McFaddin NWR include small mammals such as northern river otter (*Lontra canadensis*), raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), common muskrat (*Ondatra zibethicus*), Virginia opossum (*Didelphis virginianus*), and bobcat (*Lynx rufus*), gray fox (*Urocyon cinereoargenteus*), and coyote (*Canis latrans*). Several reptiles and amphibians can be observed within the McFaddin NWR including the American alligator (*Alligator mississippiensis*), and approximately 300 species of birds have also been documented during various times of the year.

The McFaddin NWR lies within a biogeographical region known as the Chenier Plain (Gosselink et al., 1979). Geographically, the Chenier Plain region extends from Vermillion Bay in southwestern Louisiana to East Bay in southeastern Texas. A distinguishing feature of the region is the presence of cheniers (ridges representing the ancient Gulf shorelines), which are generally aligned parallel to the Gulf or as fan-shaped alluvial deposits at the mouths of rivers. The higher cheniers support woody vegetation, hence the name chenier, a French word which means "place of oaks". Cheniers are more prevalent in Louisiana than in Texas, perhaps because of the alignment of the Gulf shoreline and its proximity to the Mississippi River, the Chenier Plain region's primary sediment source. Given the region's significant annual rainfall, wetlands isolated from the Gulf by the cheniers developed into highly productive and diverse freshwater coastal marsh habitats.

The coastal marshes, prairies, and woodlots of the Chenier Plain region of southwestern Louisiana and southeast Texas comprise a hemispherically important biological area. These habitats are an important part of the primary wintering area for Central Flyway ducks and geese. Additionally, the coastal marshes, prairies, and prairie wetlands of the Chenier Plain region serve as a critical staging area for Central Flyway waterfowl migrating to and from Mexico and Central and South America. Hundreds of thousands of shorebirds, wading birds, and other marsh and water birds also winter or migrate through the region, including several identified by the USFWS as Avian Species of Conservation Concern (USFWS, 2005). Coastal prairie and coastal woodlots on the Refuge Complex and adjacent areas support over 150 migratory and resident land bird species, including nine species of grassland birds and seven species utilizing woodland habitats listed as rare and declining within the Coastal Prairies Region of Texas (Shackleford and Lockwood, 2000).

The wetland, prairie, and woodland habitats on the Refuge Complex provide important habitat for 35 of the 48 avian species listed by the USFWS as Species of Conservation Concern in the Gulf Prairies Bird Conservation Region (USFWS, 2005).

3.2 CLIMATE

The project area's subtropical climate is highly variable and exerts both short-term and long-term influences on the environment. The dynamic nature of precipitation, temperature, and wind are the climatic factors influencing water and sediment movement and subsequently the development of the Chenier Plain region.

Summers are hot and humid with prevailing southerly winds from offshore, while winters are cool and wet. Seasonal precipitation of 51.7 in. (based on a 40 year average) is fairly uniform; with the months of October, November, and March being drier than other months. The spring season and the month of September prove to be the wettest months. July receives the greatest amount of precipitation. The wettest year in the region's history had over 70 in. of rainfall (Gosselink et al., 1979).

The average annual temperature is about 68° Fahrenheit (F), with an average maximum temperature of about 77° F, and an average minimum temperature of 58° F. The average

growing season is 250 days. Temperatures are rarely lower than 25° F. Major freezes are extremely infrequent, with frost occurring only a few days during an average winter.

Tropical weather disturbances occur from late spring through late fall. Hurricanes and tropical storms cause both wind and water erosion. Storm surges and heavy rains produce abnormally large volumes of water inland, which drain to the Gulf of Mexico through restricted waterways. The predicted level of water for a hurricane in this area is 10.7 ft above mean sea level (MSL). The storm interval that would produce 15 ft tides is predicted to be 1 in 100 years, 13.5 ft tides 1 in 50 years, 10.7 ft tides 1 in 25 years, 7.8 ft tides 1 in 10 years, and 5.4 ft tides 1 in 5 years.

3.3 GEOLOGY AND SOILS

The existing physiography, soils, and geomorphology of the project region are a result of complex interactions of hydrological, meteorological, and geological processes that occurred during two epochs of the Quaternary period. River, Gulf, and subsurface aquatic systems are the primary medium for transporting and mixing sediment and nutrients. Rivers transport sediments and nutrients from inland catchment basins to the mixing and receiving basins of the estuaries, marshlands, and the Gulf of Mexico. The main source of sediment for the Chenier Plain region was reworked former delta sediments of the Mississippi River, combined with sediments of adjacent active distributaries (channels) of the Mississippi. In the Texas portion of the Chenier Plain region, sediments were also supplied by the Sabine, Neches and Trinity Rivers. Depositional and erosional processes have resulted in land gain or loss through time.

According to the *Geologic Atlas of Texas, Houston Sheet* (Aronow and Barnes, 1996), the surface geologic units present within the project area are Barrier-island deposits and Alluvium of the Holocene Era. Barrier-island deposits are present in a small ridge along the Gulf Coast within the project area. Alluvium comprises the majority of the project area, beginning immediately inland of the Barrier-island deposits.

McFaddin NWR is located within the Chenier Plain of the upper Texas Gulf Coast. Relatively high chenier beach ridges, known as the modern strandplain-chenier system, occur east of McFaddin NWR near Sabine Pass and State Highway 87. Due to erosion and shoreline retreat, a much lower and narrower “beach ridge” remains along the Gulf of Mexico within McFaddin NWR. This ridge varies in elevation from approximately 2.5 feet to 5 feet above mean sea level (MSL) between Clam Lake and High Island. Inland from the beach ridge of the McFaddin NWR and the Gulf Intracoastal Waterway (GIWW) embankment comprises the northern boundary of McFaddin NWR, a topographically lower area, predominantly composed of coastal marsh interspersed with slightly higher saline prairie habitats. Topography ranges from below MSL to approximately 2.5 feet above MSL in the marshes and saline prairie ridges.

The Chenier Plain region is part of a recent geologic plain. Most soils within the McFaddin NWR are remnants of ancient floodplains and Gulf of Mexico beaches and consist of old alluvium and marine sediment deposited by ancient streams and the Gulf of Mexico. These deposits are mostly clayey and sandy soils and exhibit a wide range in textural differences due to their origin within historic floodplain systems. The McFaddin NWR in its entirety is located within the 100-year floodplain. The soil types, both acidic and alkaline, are poorly drained with

slow permeability, moderate to high salinity, and a high shrink-swell potential (Crout, 1976; USFWS, 1994a).

According to the Soil Survey of Orange and Jefferson Counties, Texas, the soil mapping units within the project area include: Beaches, very frequently flooded, tidal; Veston fine sandy loam; Barnett silty clay loam; Barnett mucky peat; Leerco muck; Caplen mucky peat; and Neel clay (**Figure 9**). The Beaches, very frequently flooded, tidal soil mapping unit consists of well sorted sand, clay and shell fragments, has very rapid permeability, is very poorly drained, and is primarily used for recreation. The Veston fine sandy loam soil mapping unit consists of loamy and clayey sediments of the Beaumont formation, has very slow permeability, and is poorly drained. This mapping unit is generally found in marshes dominated by switchgrass, gulf cordgrass, marshhay cordgrass, bushy sea-oxeye and seashore saltgrass.

The Barnett silty clay loam soil mapping unit consists of firm clayey backswamp deposits, has very slow permeability and is very poorly drained. This mapping unit is generally found in marshes dominated by marshhay cordgrass, seashore saltgrass, seashore paspalum, bushy sea-oxeye, and bulrush. The Barnett mucky peat soil mapping unit consists of firm clayey backswamp deposits, has very slow permeability and is very poorly drained. This mapping unit is generally found in marshes and dominant vegetation includes marshhay cordgrass, seashore saltgrass, seashore paspalum, bushy sea-oxeye, and bulrush.

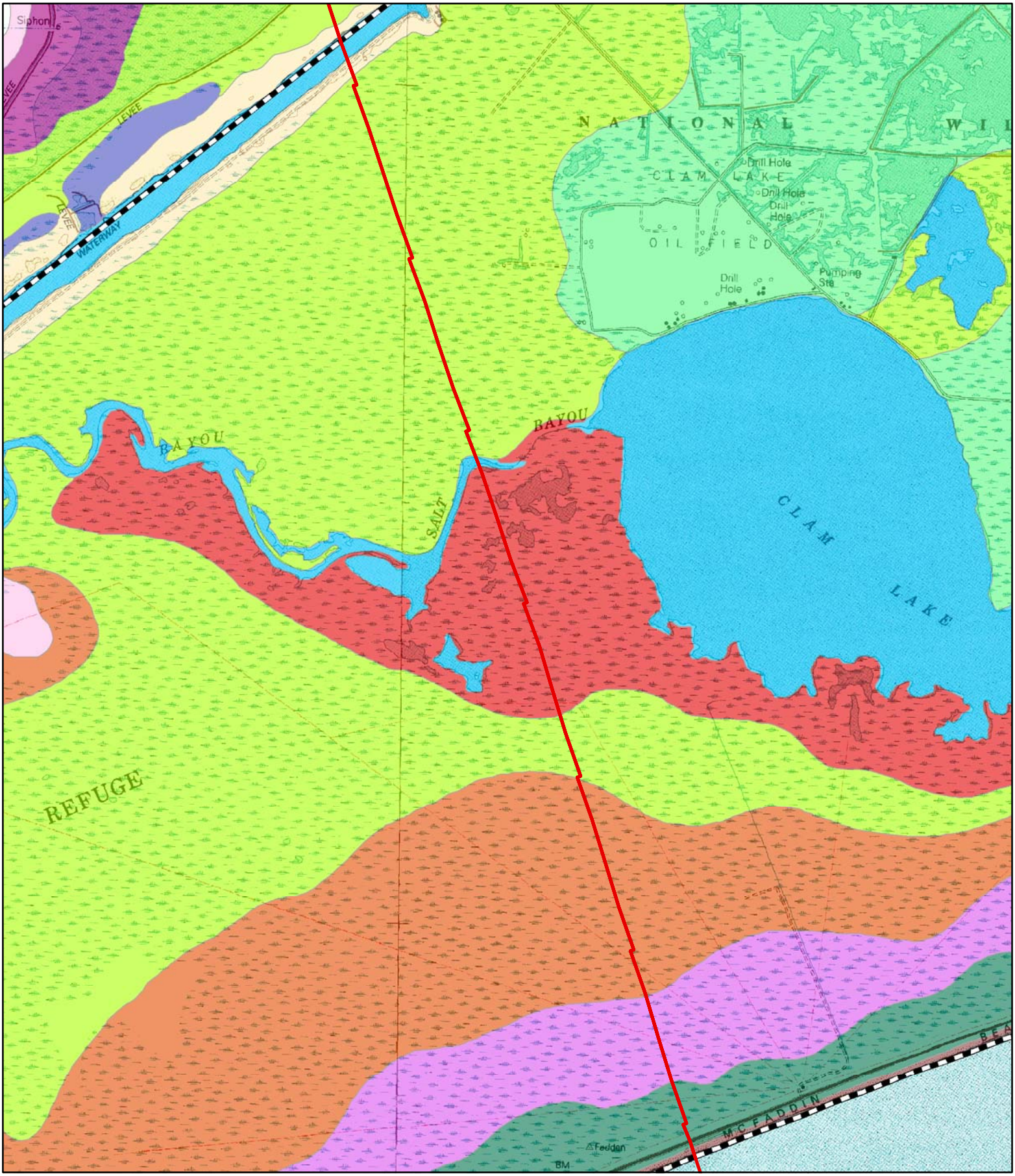
The Leerco muck, frequently flooded, tidal soil mapping unit consists of fluid clayey backswamp deposits, has very slow permeability and is very poorly drained. This mapping unit is generally found in intermediate marshes dominated by marshhay cordgrass, seashore paspalum, coast cockspur, California bulrush and olney bulrush. The Caplen mucky peat, frequently flooded, tidal soil mapping unit consists of fluid clayey backswamp deposits, has very slow permeability, and is very poorly drained. This mapping unit is generally found in marshes and is dominated by marshhay cordgrass, softstem bulrush, Olney bulrush, seashore paspalum, and coast cockspur.

The Neel clay soil mapping unit is comprised of clayey sediments, has very slow permeability, and is moderately well drained. This mapping unit is typically found in plains and is dominated by Gulf cordgrass, marshhay cordgrass, little bluestem, switchgrass, and longspike tridens.

3.4 HYDROLOGY AND WATER QUALITY

The historical pattern of hydrology in the Chenier Plain region was critical to the building processes that created and maintained the diversity of its coastal wetlands. Frequent flooding over low bayou banks and large volumes of rainwater flowing slowly across coastal prairies and marshes provided nutrients, sediments, and freshwater to marsh systems.

Natural drainage allowed a cyclic pattern of drying and flooding under which wetland plants evolved and adapted. Over the past 5,000 years, the Chenier Plain region was predominately a freshwater coastal marsh system, but contained a continuum of coastal marsh types associated with a natural salinity gradient. This continuum of freshwater, intermediate, brackish, and saline wetlands supported a diversity of floral and faunal communities.



Legend

- Proposed GOM Lithospan Ph. I 2D Line
- McFaddin NWR Boundary

Soil Types (NRCS)

- Barnett mucky peat
- Barnett silty clay loam
- Beaches
- Caplen mucky peat
- Creole mucky peat
- Franeau clay
- Harris clay
- Ijam clay
- Leerco muck
- Neel clay
- Veston fine sandy loam
- Water

Map Produced by
Dixie Environmental Services Co., LP
April 19, 2012

GOM Lithospan 2D Phase I

Figure 9: Soil Types within Project Location

GX Technology

Jefferson County, Texas

Map Datum: NAD 1927 UTM Z15N, Meter
Map Base: 1:24K DRG from http://www.tnris.org

0 550 1,100 2,200 3,300 Feet

N

1:27,000

Modifications of regional hydrology have affected ecological and geological processes critical to the long-term integrity of coastal ecosystems in the Chenier Plain region. In general, the primary human-induced activities that have affected coastal wetlands include construction of the GIWW and smaller navigation canals; oil, gas and groundwater extraction; and channelization and deepening of natural waterways for navigation and inland drainage. The consequences of these activities have resulted in various ecological responses, some of which are directly responsible for the onset of others (Stutzenbaker, 1990; White and Tremblay, 1995).

The project area occurs within the Sabine Lake watershed. Several estuarine and palustrine lakes, marshes, and sloughs are located on or traverse the project area. Those that have been named include Clam Lake and Five-Mile Cut (Salt Bayou). Completion of the GIWW cut off and diverted freshwater inflows as it divided the once continuous watersheds and marsh systems in the project area. The GIWW forms a portion of the northern boundary of McFaddin NWR. The elevated banks of the GIWW, comprised of soils excavated during the canal's construction, are eroding rapidly. Maintenance of these levees is a key management strategy to protect the interior marshes in the McFaddin NWR from saltwater intrusion. **Figure 10** provides a depiction of the waters and wetlands present within the project area.

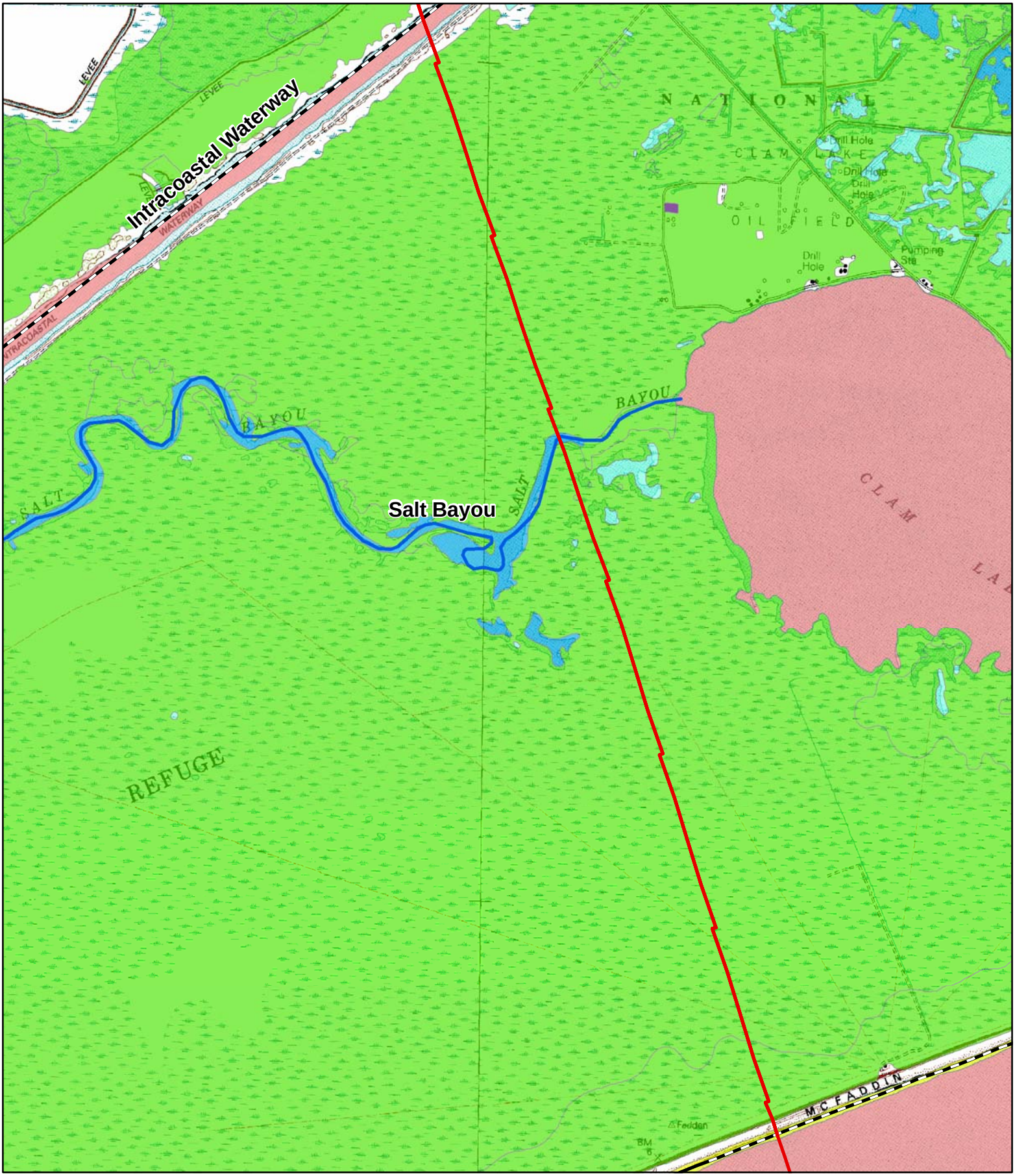
3.5 VEGETATION AND HABITAT

Vegetation communities McFaddin NWR are primarily determined by soil type, water depth and salinity. These vegetation communities are important for waterfowl, shorebirds, wading birds, and other water birds wintering on or migrating through the upper Texas Gulf Coast.

Wetland habitats within the Chenier Plain region include coastal marshes, forested wetlands along major river and bayou systems, natural and man-made wetlands (i.e. reservoirs, livestock ponds, rice fields) associated with upland prairies inland of the marshes, and open water of bays, rivers bayous and other waterways. Wetland habitats include estuarine, palustrine, riverine, and lacustrine wetlands (Moulton et al., 1997).

The intermediate, brackish, and saline emergent marshes found within the Refuge Complex are estuarine intertidal emergent wetlands [USFWS, National Wetland Inventory (NWI)]. Freshwater wetland habitats within the Refuge Complex include palustrine emergent (fresh marsh and wet prairies) and some natural "prairie wetlands." Estuarine intertidal emergent, palustrine emergent and palustrine forested wetlands are all recognized as nationally-declining wetland types (USFWS, NWI). Several categories of estuarine intertidal and freshwater (palustrine) wetlands are recognized as nationally-declining wetland types (USFWS, NWI).

Open water habitats were historically vegetated by a diverse group of submerged aquatic vegetation, with freshwater species consisting of plants such as American lotus, long leaf pondweed, fanwort, and coontail. Species such as the blue water lily, white water lily, banana water lily, baby pondweed, sago pondweed, and southern naiad are considered intermediate tolerant species for salinity. Widgeon grass, a more salt tolerant species, historically vegetated the open water areas as well.



Legend

- Proposed GOM Lithospan Ph. I 2D Line
- Waterways
- McFaddin NWR Boundary

NWI Data (USFWS)

Wetland Type

- Estuarine and Marine Deepwater
- Estuarine and Marine Wetland
- Freshwater Emergent Wetland
- Freshwater Pond
- Lake
- Other

0 750 1,500 3,000 4,500 Feet

N

1:27,000

Map Produced by
Dixie Environmental Services Co., LP
April 19, 2012

GOM Lithospan 2D Phase I

Figure 10: Wetlands and Waterways in Project Location

GX Technology

Jefferson County, Texas

Map Datum: NAD 1927 UTM Z15N, Meter
Map Base: 1:24K DRG from http://www.tnris.org

Upland habitats present within the Refuge Complex include salty prairies, remnant tall-grass prairies, and small remnant woodlands. Salty prairies occur as elevated ridges interspersed within marsh habitats.

Other upland habitats found on the Refuge Complex are the beach ridges and dunes along the Gulf of Mexico and small coastal woodlands located on the chenier ridges or on elevated features (both natural and man-made) including bayou banks and levees. Typical woody vegetation present in coastal woodland areas include; red mulberry, hackberry, Chinese tallow, live oak, southern wax myrtle, yaupon holly, and sweetgum. These woodlots are heavily used rest areas during spring and fall migrations by neotropical migrant birds.

No endangered or threatened plants as listed by the USFWS and/or TPWD occur within Jefferson County; however, the Chapman's orchid (*Platanthera chapmanii*) is listed by the TPWD as a rare species of concern.

Scientific names of the vegetation referenced in this section were not included in the text; however, all vegetation referenced in this section is included in **Tables 5, 6** and **7,** along with scientific names.

3.5.1 Wetland and Aquatic Habitats

3.5.1.1 Estuarine and Palustrine Wetlands

Estuarine and marine deepwater areas comprise approximately 1.32 ac or 1.34 % of the project area. Freshwater emergent wetlands comprise approximately 93.44 ac or 94.88 % of the project area and include the continuum of coastal marsh types found in the Chenier Plain region, from fresh to saline along a salinity gradient. Lakes comprise the smallest percentage of the project area (0.86 ac, 0.87%). This continuum includes the palustrine freshwater marshes, whose average water salinity is less than 0.5 parts per thousand (ppt). Estuarine marshes include intermediate marsh (salinity range for 0.5 to <5.0 ppt with an average salinity of 3.3 ppt), brackish marsh (salinity range of 5.0 to 18.0 ppt with an average salinity of 8.0 ppt), and saline marsh with salinities over 18.0 ppt. Emergent and aquatic plant species have different tolerances to salinity, and water and soil salinities are therefore important factors influencing plant species composition and thus, fish and wildlife species composition, in the various marsh types**. Table 5** lists the common indicator plant species for the emergent marsh types and aquatic habitats occurring in the project area.

Both local precipitation and drainage of inland waters along natural and man-made waterways provide freshwater inflows to the project area's coastal marshes. The freshwater marsh and wet prairies generally occur adjacent to the upland prairies, where freshwater from precipitation and/or inland drainage accumulates in level and low-lying areas. These palustrine emergent wetlands are non-tidal, and receive influx of saltwater only under high storm surge conditions generated by the more severe hurricanes and tropical storms. Plant species found exclusively in the freshwater marsh are only salt tolerant at very low levels.

Estuarine/Marine Deepwater Areas
The intermediate marsh generally lies seaward of the fresh marsh. These estuarine marshes are primarily micro-tidal (i.e. are not subject to daily tidal action) but receive influxes of saltwater during higher tides associated with storms and the vernal and autumnal equinoxes. Intermediate marsh is the predominant marsh type on the Refuge Complex, and contains the greatest overlap of plant species whose salinity tolerances range from fresh to brackish. Common emergent plant species include marshhay cordgrass, Olney bulrush, and seashore paspalum.

Brackish marshes lie generally seaward of intermediate marshes and adjacent to tidally influenced waterways. Brackish marshes receive greater tidal influx than intermediate marshes. Common emergent plant species include marshhay cordgrass, seashore saltgrass, and saltmarsh bulrush.

Saline marshes are subject to daily tidal influences. These marsh areas lie adjacent to bays and other tidally influenced waterways. Smooth cordgrass and black rush are the two dominant emergent plant species found in saline marshes.

The full continuum of marsh types supports highly diverse and productive biological communities, and conservation of biological diversity in the project area is dependent on maintaining this continuum of wetland habitats. Plant and animal diversity is greater in the fresh and intermediate marshes than in the brackish and saline marsh types. Intermediate marsh receives the highest use of any of the marsh types by wintering and migrating waterfowl and by many wading bird species. Fresh, intermediate and brackish marshes are extremely important to migratory waterfowl. Brackish and saline marshes provide important habitat for many shorebird and colonial-nesting waterbird species, and are the primary nursery habitat for larval and post-larval stages of many commercially and recreationally-important marine fish and shellfish species.

Palustrine emergent, or freshwater emergent, wetlands within the project area include natural "prairie wetlands". Prior to the conversion of native prairie to agricultural and other land uses, these isolated, shallow freshwater wetlands were interspersed throughout the region's native coastal prairie grasslands. From the mid-1950s to the early 1990s, losses of palustrine emergent wetlands were the greatest among all wetland types on the Texas Gulf Coast (Moulton et al., 1997). Over 235,000 ac were lost during this period, and the average annual net loss for these wetlands was 6,355 ac. Rural and urban development and conversion of the native prairie to agricultural land uses were the primary factors for this loss. These natural prairie wetlands can currently be found only within the few remnant stands of uncultivated native prairie located within the project area.

3.5.1.2 Aquatic Habitats
Aquatic habitats within the McFaddin NWR within the project area include all inland open water bodies. These open water bodies include ponds, lakes, bayous, sloughs, tidal creeks, drainage ditches, and canals.

Similar to estuarine and palustrine emergent wetlands, inland open water habitats occur along a salinity gradient that ranges from below 0.5 ppt (fresh) to over 25 ppt (saline). Plant

communities vary greatly as the salinity changes along the gradient. Saline open water habitat is generally shallow and turbid and is not likely to support any rooted vascular plants. Phytoplankton are the most likely plant or plant-like species to occur in this habitat. As salinity decreases, the potential for, and the diversity of vascular plants increases. Common vascular plant species include a number of rooted and floating aquatic plant species such as widgeon grass, several pondweeds, banana water lily and American lotus (**Table 5**).

Salinity ranges in inland open water habitats have a significant influence on the plant and animal community composition that occurs in these habitats. In general, the salinity gradient produces high species richness.

Table 5: Common Indicator Plant Species Of Wetland and Aquatic Habitats on the Texas Chenier Plain National Wildlife Refuge Complex

Marsh Type	Associated Plant Species	
	Common Name	**Scientific Name**
Saline	Smooth cordgrass	*Spartina alterniflora*
	Glassworts	*Salicornia* spp.
	Marshhay cordgrass	*Spartina patens*
	Maritime saltwort	*Batis maritime*
	Seashore saltgrass	*Distichlis spicata*
	Black rush	*Juncus roemerianus*
	Saline marsh aster	*Aster tenuifolius*
	Carolina wolfberry	*Lycium carolinianum*
	Bushy sea-oxeye daisy	*Borrichia frutescens*
Brackish	Saltmarsh bulrush	*Bulbuschoesus robustus*
	Widgeon grass	*Ruppia maritima*
	Dwarf spikerush	*Eleocharis parvula*
	Marsh pea	*Vigna luteola*
	Water hemp	*Amaranthus australis*
	Marshhay cordgrass	*Spartina patens*
	Seashore saltgrass	*Distichlis spicata*
Intermediate	Olney bulrush	*Bulbuschoesus olneyi*
	Coastal water hyssop	*Bacopa monneri*
	California bulrush	*Scirpus californicus*
	Banana water lily	*Nymphaea mexicana*
	Colorado river hemp	*Sesbania macrocarpa*
	Marshhay cordgrass	*Spartina patens*
	Seashore paspalum	*Paspalum virginatum*
	Baby pondweed	*Potamogeton pusillus*
	Sand spikesedge	*Eleocharis montevidensis*
	Narrow leaf cattail	*Typha angustifolia*
	Common reed	*Phragmites australis*
	Spikerushes	*Eleocharis* spp.
	Sago pondweed	*Potamogeton pectinatus*
	Coast cockspur	*Echinochloa walteri*
	Sprangletop	*Leptochloa* spp.

Table 5: Common Indicator Plant Species Of Wetland and Aquatic Habitats on the Texas Chenier Plain National Wildlife Refuge Complex		
Marsh Type	**Associated Plant Species**	
	Common Name	**Scientific Name**
Fresh	Maiden cane	*Panicum hemitomon*
	Duckweed	*Lemna* spp.
	Giant cutgrass	*Zizaniopsis miliacea*
	Fanwort	*Cabomba caroliniana*
	Rice cutgrass	*Leersia oryzoides*
	Watershield	*Rasenia scherberi*
	Marsh millet	*Echinochloa* spp.
	American lotus	*Nelunbo lutea*
	Arrowheads	*Sagittaria* spp.
	Blatterworts	*Utricularia* spp.
	White water lily	*Nymphaea odorata*
	Marshhay cordgrass	*Spartina patens*
	Alligatorweed	*Alternathera philoxeroides*
	Jamaica sawgrass	*Cladium jamaicense*
	Southern naiad	*Najas guadalupensis*
	Smartweeds	*Polygonum* spp.
	Flat sedges	*Cyperus* spp.
	Sand rush	*Eleocharis montevidensis*
	Sprangletop	*Leptochloa* spp.
	Longtom	*Paspalum lividum*
	Burrheads	*Echinodorus* spp.
	Squarestem spikerush	*Eleocharis quadrangulata*
	Rattlebox	*Sesbania texana*
Inland Open Water[1]	Sago pondweed	*Potamogeton pectinatus*
	Duckweed	*Lemna* spp.
	Southern naiad	*Najas guadalupensis*
	Water lettuce	*Pistia stratiotes*
	Widgeon grass	*Ruppia maritima*
	Alligatorweed	*Alternathera philoxeroides*

[1] (ditches, canals, tidal creeks, bayous, lakes, and ponds)

3.5.2 Uplands

The Refuge Complex has four different upland habitats. The habitats are classified as native prairie (salty prairie and non-saline tall grass prairie), upland forest and woodlots, as well as beach and dunes. Salty prairie, beach and dunes occur within the project area.

3.5.2.1 Native Prairie

Salty prairie habitats are found on low-lying coastal ridges and flats, which are slightly higher in elevation than the adjacent marshes. Plant communities typical of salty prairies can also be found on elevated man-made features including dredged material deposits (spoil) and levees. Salty prairies are characterized by the presence of gulf cordgrass as the dominant vegetative species. Other common native plant species include knotroot bristlegrass, bushy bluestem, seaside goldenrod, western ragweed, wooly rosemallow, saltmarsh aster, seepweed, annual sumpweed, and bigleaf sumpweed (**Table 6**).

Highly disturbed salty prairie sites are likely to also include species such as rabbitfoot grass, shoregrass, bushy ox-eye daisy, and salt heliotrope. Salty prairies provide important nesting habitat for mottled ducks, a resident waterfowl species (Stutzenbaker, 1988).

Table 6: Indicator Plant Species of Terrestrial Upland Habitats on the Texas Chenier Plain National Wildlife Refuge Complex

Upland Habitat Type	Associated Plant Species	
	Common Name	**Scientific Name**
Salty Prairie	Gulf cordgrass	*Spartina spartinae*
	Knotroot bristlegrass	*Seteria geniculata*
	Seaside goldenrod	*Solidago sempervirens*
	Eastern baccharis	*Baccharis halimifolia*
Native Prairie (non-saline)	Little bluestem	*Schizachyrium scoparium*
	Indiangrass	*Sorgastrum nutans*
	Switchgrass	*Panicum virgatum*
	Brownseed paspalum	*Paspalum plicatulum*
	Southern wax myrtle	*Myrica cerifera*
	Bushy bluestem	*Andropogon glomeratus*
	Panicum grasses	*Panicum* spp.
Prairie Grasslands (non-saline)	Broomsedge bluestem	*Andropogon virginicus*
	Bushy bluestem	*Andropogon glomeratus*
	Brownseed paspalum	*Paspalum* spp.
	Vaseygrass	*Paspalum urvillei*
	Bermuda grass	*Cynodon dactylon*
	Blue verbena	*Verbena brasiliensis*
	Seacoast sumpweed	*Iva annua*
	Giant ragweed	*Ambrosia trifida*
	Southern dewberry	*Rubus trivialis*
	Eastern baccharis	*Baccharis halimifolia*
	Chinese tallow	*Sapium sebiferum*
Upland Forest and Woodlots	Hackberry	*Celtis occidentalis*
	Red mulberry	*Morus rubra*
	Black willow	*Salix nigra*
	Live oak	*Quercus virginiana*
	Common persimmon	*Diospyros virginiana*
	Sugarberry	*Celtis laevigata*
	Prickly ash	*Zanthoxylum clava-herculis*
	Slash pine	*Pinus elliottii*
	Salt cedar	*Tamarix gallica*
	Chinese tallow	*Sapium sebiferum*

Table 6: Indicator Plant Species of Terrestrial Upland Habitats on the Texas Chenier Plain National Wildlife Refuge Complex		
Upland Habitat Type	**Associated Plant Species**	
	Common Name	**Scientific Name**
Beach Ridges and Dune	Sea purslane	*Sesuvium maritium*
	Whorled dropseed	*Sporobolus pyramidatus*
	Saltmeadow cordgrass	*Spartina patens*
	Bitter panicum	*Panicum amarum*
	White morning-glory	*Ipomoea stolonifera*
	Camphor daisy	*Haglopappus phyllocephalus*
	Silver croton	*Croton punctatus*
	Virginia dropseed	*Sporobolus virginicus*
	Goat-foot morning-glory	*Ipomoea pes-caprae*
	Beach evening primrose	*Oenothera drummondii*
	Glassworts	*Salicornia* spp.
	Salt heliotrope	*Heliotropium curassavicum*
	Sea-lavender	*Limonium carolinianum*
	Bushy ox-eye daisy	*Borrichia frutescens*

Many faunal species typical of prairies, such as Henslow's sparrow, smooth green snake, and prairie voles, were found year round in the Gulf Coast prairies. Dickcissels still nest in these coastal grasslands, and many other avian species utilize Gulf Coast prairies as wintering and /or migratory habitat. Many of the birds that would benefit from protection and management of native coastal prairie habitats are species that are declining in the Coastal Prairies Region of Texas (Shackelford and Lockwood, 2000), and /or are among several species listed by USFWS as "Avian Species of Conservation Concern" (ASCC) in the Gulf Prairies Bird Conservation Region (USFWS, 2002). For example, mottled duck, white-tailed hawk, northern bobwhite, yellow rail, black rail, buff-breasted sandpiper, short-eared owl, sedge wren, and LeConte's sparrow are all species of conservation concern that utilize native prairie habitats.

The mottled duck is a southern species that spends its whole life cycle in coastal prairies and adjacent marshes. The historical prairie-wetland continuum of the upper Texas coast provided nesting cover and brood habitat in close proximity. In a study of mottled ducks nesting in agricultural lands in Louisiana, the habitat category that was most like native coastal prairie, permanent pasture with knolls, provided better nesting habitat than any other (Durham and Afton, 2003). The dense nesting cover and mima mounds that are characteristic of coastal prairie probably provided excellent nesting habitat for resident mottled ducks. Stutzenbaker (1988) identified shallow depressional wetlands found in the prairie zone, known as "sennabean ponds" as a valuable brood rearing habitat for this species.

3.5.2.2 Beach, Beach Ridges, and Dunes

Gulf of Mexico beaches along the McFaddin NWR's southern boundary are generally narrow and fairly steep, backed by a low beach ridge/dune complex (Morton, 1998). Coarse sediment supply was probably never in this mud-dominated littoral system, and it has been further decreased by river diversions, dams, navigational channels, and jetty systems (Texas GLO, 1996). Most of the Gulf of Mexico shoreline on the McFaddin NWR is retreating, resulting in a loss of vegetated beach dune ridge, salty prairie, and marsh habitats.

The vegetation of beach/beach ridge and dunes is a mixture of typical salt-tolerant marsh and beach plants, characteristic of subtropical areas (Gosselink, et al., 1979) (**Table 7**). Plants typical of this habitat include saltmeadow cordgrass, camphor weed, bitter panicum, gulf croton, common cocklebur, coast dozedaisy, little bluestem, Indiangrass, and switchgrass (**Table 7**). Traditional salt tolerant species behind dunes and ridges are those found in vegetated salt flats such as shoregrass, Bigelow glasswort, Virginia glasswort, maritime saltwort, salt heliotrope, sea lavender, and bushy sea oxeye daisy (**Table 7**). When grasses are overgrazed, Bermuda grass, carpet grass, and annual weeds and forbs invade the habitat. Overall, plant productivity in beach habitats is limited.

3.6 FISH AND WILDLIFE

The Refuge Complex provides important habitats for hundreds of fish and wildlife species. Located along the coast, the McFaddin NWR provides critical habitat to both freshwater and saltwater fish and other aquatic species, as well as resident and migratory birds.

3.6.1 Avian Species

A total of 285 avian species have been recorded on the Refuge Complex, of which 52 species have been documented nesting within the Refuge Complex. Wetland habitats of the project area support major concentrations of wintering and migrating waterfowl, shorebirds, and wading birds and provide important habitat for many species of marsh birds and water birds. Many species of land birds, including many species of neo-tropical migrants, use the coastal woodlots and other forested habitats within and adjacent to the project area in large numbers during the spring and fall migrations. Remnant stands of native prairie and other upland grassland habitats provide habitat for many grassland songbirds, including several species whose continental populations are in decline. Birds commonly observed within the Refuge Complex are listed in **Table 7**. Bird species known to nest within the Refuge Complex are listed in **Table 8**.

Table 7: Avian Species Frequently Observed on the Texas Chenier Plain Complex		
Pied-billed Grebe	Mottled Duck	Long-billed Dowitcher
Eared Grebe	Mallard	Common Snipe
Laughing Gull	Northern Pintail	Mourning Dove
American White Pelican	Northern Shoveler	Loggerhead Shrike
Ring-billed Gull	Gadwall	Swamp Sparrow
Double-crested Cormorant -	Lesser Scaup	Red-winged Blackbird
Gull-billed Tern	Ruddy Duck	Eastern Meadowlark
Least Bittern	Northern Bobwhite	Brown-headed Cowbird
Forster's Tern	Clapper Rail	House Sparrow
Great Blue Heron	King Rail	Horned Lark
Great Egret	Common Moorhen	Savannah Sparrow
Snowy Egret	American Coot	Sedge Wren
Tricolored Heron	Killdeer	European Starling
Cattle Egret	Black-necked Stilt	Seaside Sparrow
Green Heron	Greater Yellowlegs	Common Grackle
Common Yellowthroat	Lesser Yellowlegs	Boat-tailed Grackle
Black-crowned Night Heron	Willet	Turkey Vulture
White Ibis	Long-billed Curlew	Northern Harrier
White-faced Ibis	Semipalmated Sandpiper	Red-tailed Hawk

Table 7: Avian Species Frequently Observed on the Texas Chenier Plain Complex		
Pied-billed Grebe	Mottled Duck	Long-billed Dowitcher
Roseate Spoonbill	Western Sandpiper -	
Green-winged Teal	Dunlin	

Table 8: Avian Species Known to Nest on the Texas Chenier Plain Complex		
American Coot	Masked Duck	Dickcissel
Black-bellied Whistling-Duck	Mottled Duck	European Starling
Black-crowned Night-Heron	Mourning Dove	Downy Woodpecker
Black-necked Stilt	Northern Bobwhite	Eastern Kingbird
Blue-winged Teal	Pied-billed Grebe	Barn Swallow
Cattle Egret	Purple Gallinule	Boat-tailed Grackle
Clapper Rail	Ruddy Duck	Common Nighthawk
Common Moorhen	Snowy Egret	Loggerhead Shrike
Crested Caracara	Tricolored Heron	Northern Cardinal
Fulvous Whistling-Duck	Willet	Common Yellowthroat
Great Blue Heron	Yellow-billed Cuckoo	Red-winged Blackbird
Great Egret	Yellow-crowned Night-Heron	Barn Owl
Green Heron	House Sparrow	Brown-headed Cowbird
Inca Dove	Northern Mockingbird	Painted Bunting
Killdeer	Carolina Chickadee	Scissor-tailed Flycatcher
King Rail	Seaside Sparrow	Horned Lark
Least Bittern	Purple Martin	Marsh Wren
Least Tern	Eastern Meadowlark	
Little Blue Heron	Orchard Oriole	

3.6.1.1 Waterfowl

The coastal marshes, wet prairies, rice fields, and moist soil units of the Refuge Complex are used by 27 species of ducks and five species of geese including lesser snow geese, Ross's geese, greater white-fronted geese, Canada geese, and black brant (rare) (USFWS, 1994b). The Refuge Complex is part of the southern terminus for most ducks and geese of the Central Flyway, and also some waterfowl from the Mississippi, Atlantic and Pacific Flyways that winter on the Texas Gulf Coast. The 2011 Mid-winter Waterfowl Survey for the Central Flyway indicated that 8,335,682 waterfowl used the Central Flyway. Of those birds, 5,273,129 waterfowl (63.26 %) wintered in Texas.

The USFWS conducts aerial waterfowl surveys monthly from September through March on NWRs on the Texas Gulf Coast. Between 1997 and 2007, numbers of ducks peaked at 173,152 in December 1998 on McFaddin NWR (**Table 9**). During the same survey period, goose populations peaked at 97,786 in January 2001 on McFaddin NWR (**Table 10**). Aerial waterfowl survey counts were not available for more recent than 2004 for McFaddin NWR. The most common duck species observed were, in order of abundance, American green-winged teal, gadwall, northern shoveler, blue-winged teal, and northern pintail.

Following the top five species were American widgeon, mallard, and mottled duck, respectively. Snow geese are the principal goose species found on the Refuge Complex. Other geese include the greater white-fronted goose, Canada goose, and Ross' goose.

Table 9: Number of Ducks Counted During Aerial Winter Waterfowl Surveys on McFaddin NWR								
Year	**Sept**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**High Count**
1997/1998	3356	17561	23533	39308	80756	51387	107821	**107821**
1998/1999	63306	38138	62032	173152	70570	117599	104864	**173152**
1999/2000	16788	35323	44490	66127	46912	51665	25626	**66127**
2000/2001	26010	10485	30489	30743	75781	49704	153206	**153206**
2001/2002	16631	78	16231	1517	28635	*	43621	**43621**
2002/2003	28	387	644	14930	6847	*	6591	**14930**
2003/2004	420	3779	7049	7461	20421	30722	26793	**30722**
Average	**18,077**	**15,107**	**26,353**	**47,605**	**47,132**	**60,215**	**66,932**	**84,226**

* Survey not conducted

Table 10: Number of Geese Counted During Aerial Winter Waterfowl Surveys on McFaddin NWR								
Year	**Sept**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**High Count**
1997/1998	0	187	9674	13350	55081	56477	0	**56477**
1998/1999	0	952	3908	12865	11985	10338	1254	**12865**
1999/2000	0	353	621	4796	21143	11407	0	**21143**
2000/2001	0	0	2330	79993	97786	78186	101	**97786**
2001/2002	0	0	0	203	47046	*	3759	**47046**
2002/2003	0	0	536	288	18258	*	0	**18258**
2003/2004	0	0	224	1238	1804	1707	0	**1804**
Average	**213**	**2,470**	**16,105**	**36,158**	**31,623**	**731**	**36,483**	**213**

* Survey not conducted

The McFaddin NWR provides important year-round habitat for the resident mottled duck. Although not in large numbers, other waterfowl species nesting in the area include blue-winged teal, ruddy duck, and masked duck (a rare species). Nesting populations of fulvous and black-bellied whistling ducks have increased in recent years.

The mottled duck is a resident waterfowl species that is entirely dependent upon coastal habitats along the Gulf of Mexico. Two populations of mottled duck are recognized; one in Florida, and the western Gulf population, which utilizes coastal habitats in Alabama, Mississippi, Louisiana, Texas, and Mexico. No interchange between these two populations is believed to occur. Mottled duck numbers in Texas have declined in recent years. The Upper Texas Gulf Coast, including the Refuge Complex, has historically been the core of mottled duck habitat in Texas. Wetland and grassland habitat, as well as agricultural fields, primarily rice, continue to be extremely important to the western Gulf population of mottled ducks.

3.6.1.2 Shorebirds, Wading Birds, Marsh Birds, and Water Birds

The tidal flats, beaches, and marshes on the McFaddin NWR and adjacent areas within the project area provide shallow water feeding, breeding, and resting habitat for numerous shorebirds, wading birds, marsh birds, and other water birds.

Thirty-two species of shorebirds regularly occur on the Refuge Complex, ten of which are considered "highly imperiled" or of "high concern." Common nesting shorebird species include: killdeer, black-necked stilt, and willet. Other shorebird and related species commonly observed in the project area include long-billed curlew, Wilson's snipe, ringed-billed gull, laughing gull, herring gull, least tern (a nesting species), royal terns, and Caspian terns (USFWS, 1997).

Small rookeries of colonial nesting birds occur throughout the Chenier Plain region, including rookeries inhabited by the following wading birds: great egret, snowy egret, cattle egret, green heron, great blue heron, black-crowned night heron, yellow-crown night heron, and roseate spoonbill. Nesting colonies of other colonial nesters including least terns and black skimmers occur on beaches, wash-over terraces, and occasionally on man-made sites such as oil and gas well pad sites. On the Refuge Complex, nesting and/or wading, marsh and water bird species include great blue heron, little blue heron, green heron, tri-colored heron, great egret, snowy egret, American bittern, least bittern, common moorhen, purple gallinule, pied-billed grebe, least tern, and American coot (USFWS, 1997).

All six North American species of rail occur in the marshes and wet prairie grasslands of the project area. King and clapper rails nest on the Refuge Complex and are present year-round. The black rail has not been documented as nesting on the Refuge Complex, but is also present year-round. Sora, Virginia, and yellow rails utilize these habitats during spring and fall migrations.

3.6.1.3 Migratory and Resident Land Birds

Many passerines that nest in temperate North America and winter in Central and South America migrate through the Chenier Plain region, crossing the Gulf of Mexico during spring and fall migrations. During spring migrations, coastal woodlots, alluvial forest, and other wooded habitats in the project area provide the first landfall for these trans-Gulf neo-tropical migrants. Migrant passerines that use the Refuge Complex include many species of warblers, vireos, tanagers, thrushes and buntings, as well as many ASCC (USFWS, 2005). Songbird species nesting on the Refuge Complex include orchard oriole, eastern kingbird, and scissor-tailed flycatcher.

Native prairie remnants and other upland grassland habitats on the Refuge Complex provide wintering and migration habitat for several grassland songbird species, including LeConte's sparrow and Nelson's sharp-tailed sparrow, and nesting habitat for dickcissel and eastern meadowlark among others.

Several species of raptors commonly observed in the project area include red-tailed hawk, red-shouldered hawk, turkey vulture, American kestrel, white-tailed kite, northern harrier and short-eared owl (USFWS, 1994a). Many other raptor species are observed during spring and fall migrations.

Several hundred thousand people, including many international visitors, visit the Refuge Complex annually from late March to early May to bird watch during spring migration. Popular destinations on or near the project area include the Refuge Complex, local State Wildlife

Management Areas and State Parks, the Audubon Society Preserves at High Island and Bolivar Flats, and the Texas Ornithological Society Sabine Woods Sanctuary in Sabine Pass.

3.6.1.4 Avian Species of Conservation Concern

Conservation priorities for North American avian species and recommendations for habitat protection, management and restoration in support of conservation of these species have been developed and identified recently through several international, national and regional avian conservation plans. These plans include the North American Waterfowl Management Plan (NAWMP), United States Shorebird Conservation Plan, the North American Waterbird Conservation Plan, and the Partners in Flight Landbird Conservation Plan. At a regional level, several step-down plans have been developed to guide conservation efforts at a more local scale. Examples applicable to avian conservation on the Refuge Complex, include the Gulf Coast Joint Venture Chenier Plain Initiative Area Plan (Esslinger and Wilson, 2001) under the North American Waterfowl Management Plan and the Lower Mississippi/Western Gulf Coast Regional Plan (Elliot and McKnight, 2000) under the U.S. Shorebird Conservation Plan.

In 2008, the USFWS published a national list of "Birds of Conservation Concern." Thirty-five of the 44 BCC listed for the Gulf Coast Prairie Bird Conservation Region occur within the Refuge Complex. Wetland dependent BCC occurring on or near the project area include yellow and black rails, American bittern, Hudsonian godwit, long-billed curlew, short-billed dowitcher, least tern, seaside sparrow, and Sprague's pipit. ASCC utilizing prairie grasslands on or near the project area include LeConte's sparrow, Nelson's sharp-tailed sparrow, buff-breasted sandpiper, loggerhead shrike and white-tailed hawk.

Neo-tropical migrant landbirds listed as BCC, which utilize the woodland habitats on or near the project area, include Swainson's warbler, prothonotary warbler, and swallow-tailed kite.

The Partners in Flight (PIF) Conservation Program is an international, multi-agency and multi-organizational conservation initiative for North American landbirds and waterbirds. PIF recently completed an assessment of the status and conservation needs of all North American land and waterbirds. This assessment included consideration of population trends, habitat trends, and threats on wintering and breeding grounds. National, regional, and more local conservation priorities were determined. These species represent conservation priorities for USFWS and other PIF partners including state wildlife agencies, the United States Forest Service, and other governmental and private partners. Multi-agency PIF conservation strategies for Texas are currently under development, and these strategies will guide management activities at the local and regional scale. In Texas, the PIF partners have identified priority species for conservation, monitoring, and management in relation to the specific habitat types and seasons within the Texas Coastal Prairies Region (Shackleford and Lockwood, 2000), which include the Refuge Complex. Habitats within the project area provide wintering, migrational, and/or nesting habitat for 16 species of wetland associated birds, 9 species of grassland birds, and 13 species utilizing woodland habitats, which are listed as rare or declining within the Texas Coastal Prairies Region (**Table 11**).

Table 11: List of Rare and Declining Birds In the Coastal Prairies Region of Texas (Shackleford and Lockwood, 2000) Occurring on the Refuge Complex (per Habitat)		
Wetlands/Marshes	**Grasslands/Prairies**	**Woodlands or Scrub**
Piping Plover	Dickcissel	Swainson's Warbler
Brown Pelican	Scissor-tailed Flycatcher	Prothonotary Warbler
Bald Eagle	Whit-tailed Hawk	Yellow-billed Cuckoo
Peregrine Falcon	Loggerhead Shrike	Hooded Warbler
Reddish Egret	Northern Bobwhite	Swallow-tailed Kite
Mottled Duck	Barn Owl	Kentucky Warbler
Seaside Sparrow	Sprague's Pipit	American Woodcock
Clapper Rail	Short-eared Owl	Painted Bunting
Forester's Tern	LeConte's Sparrow	Golden-winged Warbler
Snowy Plover		Cerulian Warbler
Least Tern		Blue-winged Warbler
Black Rail		Bay-breasted Warbler
Yellow Rail		Bobolink
Wood Stork		
Hudsonian Godwit		
Buff-breasted Sandpiper		

Wetland habitats on the Refuge Complex provide important wintering and migration habitat for Central Flyway waterfowl, including several species whose continental populations are below goals established under the North American Waterfowl Management Plan (NAWMP) and/or listed by USFWS as Game Birds Below Desired Condition (USFWS, 2004). These species include the northern pintail, lesser scaup, and ring-necked duck. The mottled duck is a year-round resident of the Texas Gulf Coast, and conservation and management of this species is a major goal of the NAWMP's Gulf Coast Joint Venture Chenier Plain Initiative Area Plan (Esslinger and Wilson, 2001). Steep declines in mottled duck numbers on coastal NWRs in Texas have been documented in recent years (Haukos and Neaville, 2002), and this species is considered to be rare and declining in the Coastal Prairies Region of Texas (Shackleford and Lockwood, 2000).

Coastal marsh, coastal prairie, and agricultural habitats within Galveston, Jefferson, Chambers, and Orange Counties historically supported the highest densities of breeding mottled ducks in Texas (Stutzenbaker, 1988), and continue to be very important to the long-term conservation of this species.

The McFaddin NWR and adjacent habitats lie within the Gulf Coast Prairie Region under the U.S. Shorebird Conservation Plan (USSCP). Thirty-nine shorebird species occur in this region. This region is considered to be of "extremely high importance" to 14 of the species and of "considerable importance" for 21 additional species. Of these 35 species, 17 are considered species of conservational concern under the USSCP. Four species are considered "Highly Imperiled," which are the snowy plover, piping plover, long-billed curlew, and Eskimo curlew (believed extirpated). Thirteen species are considered "Species of High Concern," and include American golden plover, Wilson's plover, Mountain plover, American oystercatcher, whimbrel, Hudsonian godwit, marbled godwit, ruddy turnstone, red knot, sanderling, buff-breasted sandpiper, American woodcock, and Wilson's phalarope.

The North American Waterbird Conservation Plan (NAWCP) classified colonial and semi-colonial breeding waterbird species into several "at risk" categories, including "not currently at risk," "low," "moderate," "high," and "highly imperiled," and identified those species for which there is "insufficient information available to assess risk" (Kushlan et al., 2002). Wetland habitats on or near the Refuge Complex provide important wintering, migration, and/or nesting habitat for 14 colonial and semi-colonial waterbird species deemed at moderate risk, and six species deemed at high risk. High risk species include tri-colored heron, little blue heron, snowy egret, least tern (all four nest on the Refuge Complex), wood stork, and gull-billed tern.

The population status of solitary breeding marshbirds will be assessed in the second version of the NAWMP. The Refuge Complex and adjacent habitats are extremely important for many of these species, including several already identified by USFWS as ASCC. These include the yellow rail, black rail and American bittern.

Wetland habitats on or near the Refuge Complex provide important wintering, migration, and/or nesting habitat for the shorebird species identified as needing conservation attention within the Gulf Coast Prairie Region, including three "Highly Imperiled" species and ten "Species of High Concern". The three "Highly Imperiled" species are piping plover, long-billed curlew and snowy plover. The ten "Species of High Concern" include American golden plover, whimbrel, Hudsonian godwit, marbled godwit, ruddy turnstone, red knot, sanderling, buff-breasted sandpiper, American woodcock, and Wilson's phalarope.

3.6.2 Mammals

Records indicate that approximately 24 species of 48 potential mammals utilize the various habitats in or near the Refuge Complex. Some of the more common mammals found in the area include the nine-banded armadillo (*Dasypus novemcinctus*), Virginia opossum (*Didelphis virginianus*), cotton-tailed rabbit (*Sylvilagus floridanis*), swamp rabbit (*Sylvilagus aquaticus*), raccoon (*Procyon lotor*) and the striped skunk (*Mephitis mephitis*). As well, muskrat (*Ondatra zibethicus*), nutria (*Mycoaster coypus*), river otter (*Lontra canadensis*), feral pig (*Sus scrofa*), coyote (*Canis latrans*), and bobcat (*Lynx rufus*) can be observed year-round in the project area.

Mammalian species that have distributional ranges that include the Refuge Complex and could therefore inhabit the Refuge Complex are listed in **Table 12.**

Table 12: Mammalian Species with Ranges that Include the Refuge Complex (Schmidly, 1994)

Virginia Opossum *Didelphis virginiana*	Eastern Woodrat *Neotoma floridana*	Mountain Lion *Puma concolor*
Nine-Banded Armadillo *Dasypus novemcinctus*	Marsh Rice Rat *Oryzomys palustris*	Coyote *Canis latrans*
Least Shrew *Cryptotis parva*	Northern Pygmy Mouse *Baiomys taylori*	Red Fox *Vulpes vulpes*
Southern Short-Tailed Shrew *Blarina carolinensis*	Fulvous Harvest Mouse *Reithrodontomys fulvescens*	Gray Fox *Urocyon cinereoargenteus*
Eastern Mole *Scalopus aquaticus*	Eastern Harvest Mouse *Reithrodontomys humulis*	Ringtail *Bassariscus astutus*
Swamp Rabbit *Sylvilagus aquaticus*	White-Footed Deermouse *Peromyscus leucopus*	Northern Raccoon *Procyon lotor*

Table 13: Mammalian Species with Ranges that Include the Refuge Complex (Schmidly, 1994)		
Eastern Cottontail *Sylvilagus floridanus*	North American Deermouse *Peromyscus maniculatus*	American Mink *Mustela vison*
Black-Tailed Jackrabbit *Lepus californicus*	Cotton Deermouse *Peromyscus gossypinus*	Northern River Otter *Lontra Canadensis*
Muskrat *Ondatra zibethicus*	Hispid Cotton Rat *Sigmodon hispidus*	American Badger *Taxidea taxus*
Nutria *Myocastor coypus*	Mexican Free-Tailed Bat *Tadarida brasiliensis*	Long-Tailed Weasel *Mustela frenata*
American Beaver *Castor Canadensis*	Eastern Red Bat *Lasiurus borealis*	Eastern Spotted Skunk *Spilogale putorius*
Eastern Gray Squirrel *Sciurus carolinensis*	Seminole Bat *Lasiurus seminolus*	Striped Skunk *Mephitis mephitis*
Eastern Fox Squirrel *Sciurus niger*	Northern Yellow Bat *Lasiurus intermedius*	White-Tailed Deer *Odocoileus virginianus*
Southern Flying Squirrel *Glaucomys volans*	Hoary Bat *Lasiurus cinereus*	Feral Pig *Sus scrofa*
Baird's Pocket Gopher *Geomys breviceps*	Eastern Pipistrelle *Pipistrellus sublavus*	Bottlenose Dolphin *Tursiops truncatus*
Hispid Pocket Mouse *Chaetodipus hispidus*	Big Brown Bat *Eptesicus fuscus*	
Evening Bat *Nycticeius humeralis*	Bobcat *Lynx rufus*	

Muskrat and nutria populations are cyclical, and populations of these species have been relatively low in recent years. Muskrat populations in the region, as a whole, supported a once-thriving fur trapping industry. Muskrat populations on the Refuge Complex were low throughout most of the 1990's, but are currently increasing. Nutria are not native to North America, but were introduced into Louisiana in 1937. In Louisiana and some other coastal ecosystems, overpopulations of nutria have resulted in significant damage to native habitats and negative impacts to native wildlife species. Although nutria have reached high population densities in portions of Louisiana, concentrations have been localized and widespread damage has not been reported on the Refuge Complex.

3.6.3 Amphibians and Reptiles

Common amphibians within the McFaddin NWR include the cricket frog (*Acris crepitans*), southern leopard frog (*Rana sphenocephala*), green frog (*Rana clamitans*), pig frog (*Rana grylio*), Gulf Coast toad (*Bufo valliceps*), bullfrog (*Rana catesbeiana*), and several species of salamanders. The western lesser siren (*Siren intermedia*) and three-toed amphiuma (*Amphiuma tridactylum*) are seldom observed amphibians associated with freshwater habitats. A total of 46 species of frogs and toads have been documented to occur in Texas, and 23 of these species potentially could be encountered in or near the Refuge Complex. Amphibian species that have distributional ranges that include the Refuge Complex and could therefore inhabit the Refuge Complex are listed in **Table 13**.

Table 14: Amphibian Species with Ranges that Include the Refuge Complex (Schmidly, 1994)		
Western Lesser Siren *Siren intermedia*	Pig Frog *Rana grylio*	Upland Chorus Frog *Pseudacris triseriata*
Marbled Salamander *Ambystoma opacum*	Pickerel Frog *Rana palustris*	Houston Toad *Bufo houstonensis*
Three-toed Amphiuma *Amphiuma tridactylum*	Central Newt *Notophthalmus viridescens*	Gulf Coast Toad *Bufo valliceps*
Smallmouth Salamander *Ambystoma texanum*	Hurter's Spadefoot *Scaphiopus hurteri*	Woodhouse's Toad *Bufo woodhousii*
Eastern Tiger Salamander *Ambystoma tigrinum*	Coastal Cricket Frog *Acris crepitans*	Southern Crawfish Frog *Rana areolata*
Southern Dusky Salamander *Desmognathus auriculatus*	Gray Tree Frog *Hyla versicolor*	Bullfrog *Rana catesbeiana*
Dwarf Salamander *Eurycea quadridigitata*	Green Tree Frog *Hyla cinerea*	Bronze Frog *Rana clamitans*
Spring Peeper *Pseudacris crucider*	Squirrel Tree Frog *Hyla squirella*	Southern Leopard Frog *Rana sphenocephala*
Gulf Coast Water Dog *Necturus beyeri*	Spotted Chorus Frog *Pseudacris clarki*	Eastern Narrowmouth Toad *Gastrophryne carolinensis*
Strecker's Chorus Frog *Pseudacris streckeri*	Strecker's Chorus Frog *Pseudacris streckeri*	Great Plains Narrowmouth Toad *Gastrophryne olivacea*

Common reptiles in the McFaddin NWR include the American alligator (*Alligator mississippiensis*), western cottonmouth (*Agkistrodon piscivorus leucostoma*), speckled king snake (*Lampropeltis getula holbrooki*), red-eared slider (*Trachemys scripta elegans*), spiney-soft-shelled turtle (*Apalone spinifera*) and common snapping turtle (*Chelydra serpentina*). Reptilian species that have distributional ranges that overlap the Refuge Complex are listed in **Table 14**.

Table 15: Reptilian Species with Ranges that Overlap the Refuge Complex (Dixon, 2000; Conant and Collins, 1998)		
Alligator Snapping Turtle *Macroclemys temminckii*	Mediterranean Gecko *Hemidactylus turcicus*	Gulf Coast Ribbon Snake *Thamnophis proximus*
Common Snapping Turtle *Chelydra serpentina*	Nothern Fence Lizard *Sceloporus undulates*	Rough Earth Snake *Virginia striatula*
Yellow Mud Turtle *Kinosternon flavescens*	Five-lined Skink *Eumeces fasciatus*	Eastern Hognose Snake *Heterodon platirhinos*
Mississippi Mud Turtle *Kinosternon subrubrum*	Six-lined Race Runner *Cnemidophorus sexlineatus*	Smooth Green Snake *Opheodrys vernalis*
Razorback Musk Turtle *Sternotherus carinatus*	Western Slender Glass Lizard *Ophisaurus attenuates*	Corn Snake *Elaphe guttata*
Common Musk Turtle *Sternotherus odoratus*	Mississippi Green Water Snake *Nerodia cyclopion*	Texas Rat Snake *Elaphe obsolete*
Western Chicken Turtle *Deirochelys reticularia*	Diamond-backed Water Snake *Nerodia rhombifer*	Western Mud Snake *Farancia abacura*
Mississippi Map Turtle *Graptemys pseudogeographica*	Yellow-bellied Water Snake *Nerodia erythrogaster*	Prairie King Snake *Lampropeltis calligaster*
Texas Diamondback Terrapin *Malaclemys terrapin*	Broad-banded Water Snake *Nerodia fasciata*	Speckled King Snake *Lampropeltis getula*

Table 16: Reptilian Species with Ranges that Overlap the Refuge Complex (Dixon, 2000; Conant and Collins, 1998)		
Missouri River Cooter *Pseudemys concinna*	Gulf Salt Marsh Snake *Nerodia clarkia*	Louisiana Milk Snake *Lampropeltis triangulum*
Three-toed Box Turtle *Terrapene carolina*	Graham's Crayfish Snake *Regina grahamii*	Eastern Coachwhip *Masticophis flagellum*
Ornate Box Turtle *Terrapene ornate*	Gulf Crawfish Snake *Regina rigida*	Flat-headed Snake *Tantilla gracilis*
Red-eared Slider *Trachemys scripta*	Marsh Brown Snake *Storeria dekayi*	Texas Coral Snake *Micrurus fulvis*
Pallid Spiny Soft-shelled Turtle *Trionyx spiniferus*	Florida Redbelly Snake *Storeria occipitomaculata*	Southern Copperhead *Agkistrodon contortrix*
American Alligator *Alligator mississippiensis*	Eastern Garter Snake *Thamnophis sirtalis*	Western Cottonmouth *Adkistrodon piscivorus*
Green Anole *Anolis carolinensis*	Dusty Hognose Snake *Heterodon nasicus*	Western Massasauga *Sistrurus catenatus*
Texas Horned Lizard *Phrynosoma conutum*	Mississippi Ringneck Snake *Diadophis punctatus*	Western Pygmy Rattesnake *Sistrurus miliarius*
Broadhead Skink *Eumeces laticeps*	Eastern Yellowbelly Racer *Coluber constrictor*	Western Diamond-Backed Rattlesnake *Crotalus atrox*
Ground Skink *Scincella lateralis*	Rough Green Snake *Opheodrys aestivus*	Timber / Canebrake Rattlesnake *Crotalus horridus*

Alligators currently occur in 90 % of their historic range, with the largest concentrations in Texas occurring in the middle and upper coastal counties and suitable inland habitats. Preferred habitats include river valleys, streams, ox-bow lakes, swamps, estuaries, bayous, and slow moving creeks, where they will feed on fish, turtles, snakes, and small mammals such as muskrat and nutria. American alligator populations on the Refuge Complex have trended upwards since surveys of this species were initiated in the mid-1980s (USFWS, unpublished data). Alligators can now be observed in all wetland habitat types in the project area.

Harvest of alligators was re-initiated in Texas in 1984 and alligators are harvested in the Refuge Complex. TPWD sets hide tag allocations for the Refuge Complex. Annual alligator harvests on the Refuge Complex from 1998 to 2004 ranged from 250-450 alligators (USFWS, unpublished data).

3.6.4 Fish and Other Aquatic Resources

According to TPWD, over 75 species of freshwater fishes, and over 400 salt and brackish water species occur in the marshes, bays, bayous, and Gulf of Mexico waters on and adjacent to the McFaddin NWR.

The region's coastal fishery is classified as a warm water fishery resource with moderate to high numbers of salt and brackish water species occurring in the Gulf of Mexico and large estuarine bay systems. Over 95 % of the estuarine organisms inhabiting the Gulf of Mexico depend on estuarine habitats (salt, brackish, and intermediate marshes) for their survival. These species spend a portion of their life cycle, generally in the post-larval and juvenile stages, in coastal

wetlands. These include white and brown shrimp (*Litopeneaus setiferus* and *Penaeus aztecus*) and blue crab (*Callinectes sapidus*).

This natural resource base is the cornerstone for an economically very important commercial and sport fishing industry based on the harvest and sale of seafood. Millions of tons of penaid shrimp, portunid crabs, finfish, oysters, clams, and other marine life are dependent on the biological richness provided by the estuaries. Segments of the estuarine habitats are important nursery habitat for a variety of living marine resources, especially in their early life stages.

Important commercial and recreational finfish and shellfish species in the area include brown shrimp, white shrimp, American oyster (*Crassostrea virginica*), and blue crab. The major gamefish include spotted sea trout (*Cynoscion nebulosus*), sand sea trout (*Cynoscion arenarius*), and red fish or red drum (*Sciaennops ocellatus*). Other important recreational fishes include southern flounder (*Paralichthys lethostigma*), black drum (*Pogonias cromis*), Atlantic croaker (*Micropogonias undulatus*), gafttopsail catfish (*Bagre marinus*), and sheepshead (*Archosargus probatocephalus*). Ancillary species include bay anchovy (*Achoa mitchilli*), gulf menhaden (*Brevoortia tyrannus*), striped mullet (*Mugil cephalus*), and gizzard shad (*Dorosoma cepedianum*).

Freshwater fish utilizing the coastal marshes within the McFaddin NWR include largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*), warmouth (*Lepomis gulosus*), pumpkinseed (*Lepomis gibbosus*), blue catfish (*Ictalurus furcatus*), black bullhead catfish (*Ameiurus melas*), black crappie (*Pomoxis nigromaculatus*), alligator gar (*Atractosteus spatula*), freshwater drum (*Aplodinotus grunniens*), and bowfin (*Amia calva*). Declines in freshwater species across the coastal plain have been occurring for over 30 years (Anderson, et.al., 1995).

Both fishing and crabbing are popular activities in the McFaddin NWR.

3.6.5 Invertebrates

Invertebrate populations are an essential food resource for migratory bird and estuarine fish species and are vital to help meet the nutritional demands of rearing broods. Various amphipods, mysid shrimp, grass shrimp, crayfish, and numerous crabs are present within all marsh habitats in the McFaddin NWR. Some of these invertebrate populations occur in tremendous quantities. Mosquitoes, biting flies, chiggers, and red imported fire ants (*Solenopsis invicta*) are other common invertebrates. Common butterfly species include monarch (*Danaus plexippus*), little yellow (*Pyrisitia lisa*), and Gulf fritillary (*Agraulis vanilla*) butterflies. Common dragonfly species include the common green darner (*Anax junius*) and seaside dragonlet (*Erythrodiplax berenice*).

3.6.6 Threatened and Endangered Species

Several federally-listed threatened and endangered species (T&E species), in accordance with the Endangered Species Act of 1973, have the potential to occur within the project area based on documented occurrences within the respective counties. These species, as well as several

additional species, are listed by the State of Texas as endangered, threatened, or species of concern (rare).

Several recent actions by the USFWS under the Endangered Species Act have changed the status of T&E species occurring within the project area. The USFWS delisted the bald eagle in August 2007 and removed it from the T&E species list; however, it remains on the state list as threatened. Additionally, the brown pelican was delisted in 2009, but remains on the state list as endangered. As with a majority of bird species, the bald eagle and brown pelican retain federal regulatory protection under the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA).

Table 15 provides a list of state- and federally-listed threatened, endangered, or rare species of special concern, which occur or have potential to occur in Jefferson County. These species could occur on the McFaddin NWR at some time during the year (the sea turtles occur in the Gulf of Mexico adjacent to the McFaddin NWR).

Table 17: Federally- and State-Listed Threatened, Endangered, or Rare Species of Concern, with May Occur in Jefferson County, Texas.

Scientific Name	Common Name	Status[1]	Occurrence in McFaddin NWR
Amphibians			
Lithobates grylio	Pig frog	R	Known
Birds			
Falco peregrinus anatum	American Peregrine Falcon	ST	Known
Falco peregrinus tundrius	Arctic Peregrine Falcon	R	Known
Haliaeetus leucocephalus	Bald Eagle	ST	Known
Laterallus jamaicensis	Black Rail	R	Known
Pelecanus occidental/s	Brown Pelican	SE	Known
Ammodramus henslowii	Henslow's Sparrow	R	Known
Charadrius melodus	Piping Plover	ST, FT	Known
Egretta rufescens	Reddish Egret	ST	Known
Charadrius alexandrinus	Snowy Plover	R	Known
Charadrius alexandrinus tenuirostris	Southeastern Snowy Plover	R	Known
Anthus spragueii	Sprague's Pipit	FC	Not Known
Elanoides forficatus	Swallow-tailed Kite	ST	Known
Charadrius alexandrines nivosus	Western Snowy Plover	R	No habitat
Plegadis chihi	White-faced Ibis	ST	Known
Buteo albicaudayus	White-tailed Hawk	ST	Potential
Mycteria americana	Wood Stork	ST	Known
Fishes			
Anguilla americanus	American eel	R	Potential
Pristis pectinata	Smalltooth sawfish	SE, FE	Extirpated within the Region
Insects			
Euphyes bayensis	Bay skipper	R	Potential
Mammals			
Ursus americanus	Black bear	ST, FT, S/A	No Habitat
Ursus americanus luteous	Louisiana black bear	ST, FT	No Habitat

Table 17: Federally- and State-Listed Threatened, Endangered, or Rare Species of Concern, with May Occur in Jefferson County, Texas.			
Scientific Name	**Common Name**	**Status[1]**	**Occurrence in McFaddin NWR**
Spilogale putorius interrupta	Plains spotted skunk	R	Potential
Corynorhinus rafinesquii	Rafinesque's big-eared bat	ST	No Habitat
Canis rufus	Red wolf	SE, FE	Extirpated within the Region
Myotis austroriparius	Southeastern myotis bat	R	No Habitat
Mussells			
Strophitus undulates	Creeper (squawfoot)	R	No Habitat
Truncilla donaciformis	Fawnsfoot	R	No Habitat
Villosa lienosa	Little spectaclecase	R	No Habitat
Pleurobema riddellii	Louisiana pigtoe	ST	No Habitat
Lampsilis satura	Sandbank pocketbook	ST	No Habitat
Obovaria jacksoniana	Southern hickorynut	ST	No Habitat
Potamilus amphichaenus	Texas heelsplitter	ST	No Habitat
Fusconaia askewi	Texas pigtoe	ST	No Habitat
Fusconaia flava	Wabash pigtoe	R	No Habitat
Quadrula nodulata	Wartyback	R	No Habitat
Reptiles			
Macrochelys temminckii	Alligator snapping turtle	ST	Known
Eretmochelys imbricata	Atlantic hawksbill sea turtle	FE,SE	No habitat; habitat outside of McFaddin NWR boundary but adjacent
Chelonia mydas	Green sea turtle	FT,ST	No habitat; habitat outside of McFaddin NWR boundary, but adjacent
Nerodia clarkii	Gulf saltmarsh snake	R	Known
Lepidochelys kempii	Kemp's ridley sea turtle	FE,SE†	No habitat; habitat outside of McFaddin NWR boundary, but adjacent
Dermochelys coriacea	Leatherback sea turtle	FE,SE†	No habitat; habitat outside of McFaddin NWR boundary, but adjacent
Caretta caretta	Loggerhead sea turtle	FT,ST	No habitat; habitat outside of McFaddin NWR boundary, but adjacent
Cemophora coccinea copei	Northern scarlet snake	ST	No Habitat
Graptemys ouachitensis sabinensis	Sabine map turtle	R	No Habitat
Malaclemys terrapin littoralis	Texas diamondback terrapin	R	Known

Table 17: Federally- and State-Listed Threatened, Endangered, or Rare Species of Concern, with May Occur in Jefferson County, Texas.			
Scientific Name	**Common Name**	**Status[1]**	**Occurrence in McFaddin NWR**
Phrynosoma cornutum	Texas horned lizard	ST	Potential habitat; no sightings in 15 years
Crotalus horridus	Timber /canebrake rattlesnake	ST	No Habitat
Plants			
Platanthera chapmanii	Chapman's orchid	R	No habitat
[1] R= Rare Species of Concern; SE= State Endangered; ST=State Threatened; FE=Federally Endangered; FT=Federally Threatened; S/A= Similarity of Appearance; FC = Federal Candidate Species; † = Not documented to occur in the County list			

Source: USFWS, Endangered Species List, Jefferson County, Texas (April 2012)
TPWD, Annotated County Lists of Rare Species, Jefferson County (August 2012)

3.6.6.1 Federally-Listed Threatened or Endangered Species Known to Occur or with Potential to Occur within the McFaddin NWR

Birds

The piping plover, listed as threatened, overwinters on the Texas Gulf Coast. This species occurs along the Gulf beaches and other exposed mudflats within the Refuge Complex, primarily during fall migration and winter, but nesting has not been documented on the Refuge Complex. Piping plovers begin to arrive in the northern sections of the Gulf as early as mid-July and continue to arrive through October. Most move further south as the winter approaches. The piping plover feeds on invertebrates inhabiting tidal mudflats, sandflats, and algal flats. Piping plover habitat known to occur within the project area would experience small numbers of plovers wintering on the Gulf beaches of the McFaddin NWR, as well as plover presence during spring and fall migration. Piping plovers potentially could be present within any tidal flats occurring along the GIWW. According to the USFWS, there have been no records of nesting piping plovers on the Refuge Complex (USFWS, 2012a).

Fishes

Smalltooth sawfish are endangered along the Atlantic Gulf Coast. This species inhabits shallow coastal waters of tropical seas and estuaries and is usually found in shallow waters close to shore over muddy or sandy bottoms. The smalltooth sawfish feeds mostly on fish but also on crustaceans. Smalltooth sawfish likely do not inhabit the Refuge Complex, but could inhabit the coastal waters adjacent to the project area.

Mammals

The McFaddin NWR is within the historic range of the red wolf. This species has been extirpated within the region and is not anticipated to occur within the project area.

Reptiles

Three species of endangered sea turtles (Atlantic hawksbill, Kemp's ridley, and leatherback) and two species of threatened sea turtles (green and loggerhead) are known to occur in the Gulf of Mexico. The Kemp's ridley is the most endangered sea turtle. The Kemp's ridley sea turtle is

known to use shallow-water bays over its entire range to feed on blue crab, by-catch of shrimpers, algae, and seagrass beds.

Historically, all five of these sea turtles nested on the Texas Gulf Coast. The number of Kemp's ridley sea turtles nesting in Texas appears to be increasing, and this species is now nesting again in parts of its historic range, including the upper Texas Gulf Coast. To date, nesting has not been documented within the McFaddin NWR, but has been documented as far north as Crystal Beach in recent years (2008). Tracking data suggests that juvenile and adult Kemp's ridley sea turtles do frequent the Gulf of Mexico between Galveston Bay and Sabine Pass, which is near the project area and McFaddin NWR (Metz, 2011). Strandings of dead and wounded turtles occur occasionally on the beaches and shorelines of the McFaddin NWR.

3.6.6.2 State of Texas-Listed Threatened, Endangered, or Rare Species Known to Occur or with Potential to Occur on the McFaddin NWR

Birds

Peregrine Falcons
The Arctic peregrine falcon is state-listed as threatened. Due to similarity of appearance, the TPWD also affords protection to the American peregrine falcon. The Arctic peregrine falcon's wintering range includes all of the Texas Gulf Coast. The American and Arctic peregrine falcons are attracted to large concentrations of ducks and other birds during the winter. The southern coast of Texas appears to be a major spring migration staging area, and most falcons are observed on the Refuge Complex during the spring and fall migration, usually along the Gulf of Mexico shoreline.

Bald Eagles

The bald eagle is no longer federally listed; however, is state-listed as threatened. Bald eagle populations were affected by the use of organochlorine pesticides; however, the species has been making a come-back since the 1970s. Bald eagles, especially juveniles, are occasionally observed flying over the McFaddin NWR during the winter but do not nest in the project area. They are generally associated with large concentrations of wintering waterfowl. The bald eagle is further protected under the Bald and Golden Eagle Protection Act (BGEPA) and the Migratory Bird Treaty Act (MBTA).

Brown Pelicans
Brown pelicans have been federally delisted; however, are state-listed as endangered. Brown pelicans along the Texas coast experienced a population decline from the first part of the century until the mid-1970s. From numbers in the range of 5,000 at the turn of the century to less than 50 individuals in the early 1970s, the brown pelican's population decreased until the elimination of organochlorine pesticides (e.g. DTD), and the species was listed as endangered. Population increases have been documented since the late 1970s. Brown pelicans typically congregate on open waters and along shorelines of the GIWW and other waterbodies in the project region. They have been frequently observed in small to medium flocks on the Gulf shoreline at McFaddin NWR and are frequently observed flying over the Refuge (USFWS, 2012a). Brown

pelicans do not nest within the Refuge Complex, but the migratory range and potential nesting range has been documented to occur within Jefferson County (Campbell, 1995).

Reddish Egret
The reddish egret is state-listed as threatened. Reddish egrets have been observed in the brackish and intermediate marshes of the Anahuac NWR and are known to occur within the McFaddin NWR. Preferred habitats include shores, lagoons, salt marshes and salt flats where they primarily forage on fish. Breeding activity generally occurs on coastal islands where they will nest in colonies, although rarely east of Galveston, Texas (Collins, 1981). There is no documentation of nesting activity by reddish egrets within the McFaddin NWR.

Swallow-tailed Kite
The American swallow-tailed kite is state-listed as threatened. Preferred habitats consist of river bottom forests, where they nest in the tree tops near habitat edges and other openings. In recent years, nesting has been documented in bottomland forests along the Trinity River (TPWD, unpublished data). They have been observed on the North Unit of the McFaddin NWR (outside of the project area).

White-faced Ibis
The white-faced ibis is state-listed as threatened. This species is a colonial nester that is commonly observed throughout the year. White-faced ibis have nested within the McFaddin NWR. Populations of this species are believed to have been negatively impacted by the use of pesticides and herbicides used in rice production (DeGraaf et. al., 1991). Preferred habitats include freshwater marshes, sloughs, and ponds with emergent vegetation.

White-tailed Hawk
The white-tailed hawk is state-listed as threatened. White-tailed hawks are a southern species that nearly make it to the Upper Texas Coast. They are uncommon permanent residents of the coastal prairies. White-tailed hawks are occasionally seen within the McFaddin NWR in the fall and winter but rarely in the spring.

Wood Stork
The wood stork is state-listed as threatened. Some of the latest nesting records in Texas come from Chambers and Jefferson Counties (1930 and 1960, respectively) (Oberholser, 1974 and DeGraaf et. al., 1991). The wood stork generally nests in colonies in trees bordering swamps, marshes, or ponds. Wood storks typically utilize brackish marsh habitats during late summer. It is believed that these birds are dispersing post-breeding from Mexico, where nesting populations occur.

<u>Reptiles</u>
The alligator snapping turtle is state-listed as threatened. Alligator snapping turtles inhabit perennial waterbodies such as deepwater rivers, canals, lakes, and oxbows; as well as swamps, bayous, and ponds near deep running water. The species is occasionally observed in brackish coastal waters and is usually associated with waterbodies possessing mud bottoms and abundant aquatic vegetation. The alligator snapping turtle was present on the McFaddin NWR prior to Hurricane Ike.

State of Texas-Listed Species of Concern

Several species listed by the State of Texas as rare species of concern are known to occur within the McFaddin NWR. These include the pig frog, black rail, Henslow's sparrow, southeastern snowy plover, American eel, bay skipper, plains spotted skunk, Gulf saltmarsh snake, and Texas diamond-backed terrapin.

The pig frog prefers to inhabit open bodies of water with emergent vegetation. It feeds on crawfish, minnows, snakes and other small frogs and is highly territorial. Orange County has produced new records since 1998 and historic populations are known to occur within Jefferson County. The pig frog was documented on the McFaddin NWR in 1999, 2001, and 2005.

The black rail inhabits salt, brackish, and freshwater marshes, pond borders, wet meadows, and grassy swamps. Its nests are in or along edges of marshes, sometimes on damp ground, and usually hidden in marsh grass or at the base of *Salicornia* sp. Males have been documented doing territorial calls during nesting season on McFaddin NWR within one mile of the project area.

The Henslow's sparrow is a wintering migrant that is generally found in weedy fields or cut-over areas where lots of bunch grasses occur along with vines and brambles. Limited habitat may be present within the McFaddin NWR in the project area.

The southeastern snowy plover is a wintering migrant along the Texas Gulf Coast beaches and bayside mud or salt flats. It is known to inhabit barrier islands, bayshores and spoil islands, and Gulf beaches. Limited potential habitat for this species is available along the shoreline of the GIWW and Gulf of Mexico, within McFaddin NWR boundaries.

The American eel is found in coastal waterways below reservoirs to the Gulf of Mexico and is catadromous. It is typically found in aquatic habitats with access to ocean, muddy bottoms, still waters, large streams, and lakes, and it can travel overland in moist conditions. Most habitats present within McFaddin NWR would not be suitable habitat for this species with the exception of potentially 5-Mile Cut and some of the saturated emergent wetlands adjacent to these areas.

The bay skipper butterfly is also a species of concern. WildEarth Guardians submitted a request to petition the bay skipper butterfly become listed under the Endangered Species Act. Under this petition, they indicated that there were two known populations of this species; Bay St. Louis population and Texas population. Both were thought to have been extirpated by hurricanes in 2005 and 2008. This species was known to occur within the Anahuac NWR, which is outside of the project area, prior to 2009. The disappearance from Anahuac NWR is the primary reason for the aforementioned petition. No skippers have been observed on the McFaddin NWR. This species is believed to be highly dependent on tidal sawgrass marshes.

The plains spotted skunk is generally found in open fields, prairies, croplands, fence rows, forest edges and woodlands. This species is very opportunistic. Preferred habitats are not present within the project area; however, marginal habitat is present in coastal grasslands and marshes that may provide some food sources for this species.

The Gulf saltmarsh snake is able to live in harsh salty environments. The snake takes all its freshwater from prey. The snake feeds on a variety of invertebrates, including shrimp, crabs and crayfish. It is also found in grass-line coastal barrier islands and rarely in freshwater environments. It spends its entire life among saltgrass marshes and tidal wetlands.

The Texas diamondback terrapin has adapted physiologically to live in water with changing salinity. It is often restricted to brackish waters found in tidal creeks, estuaries and coastal salt marshes. This species can select when to drink based on the concentration of salt in the surrounding water. It eats crabs, gastropods, mussels, fish and aquatic vegetation.

The State of Texas also lists two types of bird-related habitat as rare in Jefferson County. These habitats include colonial waterbird nesting areas and migratory songbird fallout areas. Many rookeries are active annually in coastal Texas; therefore, there may be active rookeries present within the project area during the course of operations. Song bird fallout areas are defined as oak mottes and other woods/thickets that provide foraging/roosting sites for neotropical migratory songbirds. Habitat of this nature is not present within the project area; however, may be located adjacent and north of the project area.

The applicant and their consultants have pursued consultation with the Texas Parks and Wildlife Department, Wildlife Diversity Branch and with the USFWS Ecological Services (Clear Lake Field Office) to determine the potential for other threatened and endangered species to occur within the project area. Coordination on threatened and endangered species is also being initiated through the Section 404 Clean Water Act permitting process with the US Army Corps of Engineers Galveston District under Nationwide Permit 6.

3.7 HISTORICAL AND ARCHEOLOGICAL RESOURCES

GXT's cultural resource consultant performed a cultural resource file records review utilizing records available at the Texas Archaeological Research Laboratory (TARL) and on the Texas Historical Commission's (THC's) Texas Archeological Sites Atlas. These sources provide information regarding previously conducted archaeological surveys and previously recorded cultural resource sites within the State of Texas. In addition, these sources provide information on National Register of Historic Places (NRHP) properties, State Archeological Landmarks (SALs), Official Texas Historical Markers (OTHMs), Registered Texas Historic Landmarks (RTHLs), cemeteries, and local neighborhood surveys. This file search, concerning known cultural resources within or immediately adjacent to the boundary of the seismic survey, revealed the presence of one (1) site within the project corridor and within the McFaddin NWR. All of these sites will be mapped and/or flagged in the field for avoidance by the project crews. Additionally, a cultural resource avoidance plan (**Appendix A**) describing low impact methodology, avoidance measures for known sites and high probability areas, and procedures to be followed in the event of inadvertent discovery will be implemented as part of the SUP Special Conditions. Operations will be conducted in accordance with this plan for the protection of any unidentified cultural resources located within the project area. The SHPO issued concurrence on the plan on June 18, 2012, as indicated by stamp and signature on a letter dated May 2, 2012 from DESCO to Ms. Marie Archambeault of the Texas Historical Commission (**Appendix A**).

3.8 LAND USE

The McFaddin NWR was established on February 20, 1980, under the authority of the Migratory Bird Conservation Act of 1929. Approximately 90,000 visitors came to the McFaddin NWR in 2011 for recreational and educational activities including fishing, waterfowl hunting, wildlife observation and photography, environmental education and interpretation, and beach-related recreation. McFaddin NWR is a well-known hot spot for birding.

Waterfowl hunting is permitted on the McFaddin NWR in designated Public Hunting Areas during state-specified seasons, and includes the September teal season, youth-only hunts, regular waterfowl season, and September dove hunt. Saltwater fishing and crabbing is popular year-round.

Management activities to enhance, restore, and protect habitats for migratory birds and other native fish and wildlife species on the McFaddin NWR include water level and salinity management, prescribed burning, invasive/exotic species control, and controlled grazing. Water management infrastructure includes numerous water control structures, levees, ditches, and canals.

Prescribed burning occurs primarily from September through November. Control of several exotic plant species, which negatively impact native fish and wildlife, include Chinese tallow in terrestrial habitats and water hyacinth in aquatic habitats. Control measures for both species are ongoing within the McFaddin NWR. Finally, environmental education occurs in public use areas during the months of April and May (Schutter, 2011).

Staff from McFaddin NWR identified facilities and structures for avoidance and protection including boat rollers, concrete bridges, concrete walkways, crossings, culverts, decks, fences, fuels tanks, gates, pipe crossings, pipes under roads, public boat ramps, pumps, sewer stations, shelters, visitor center, water control structures (WCS), and water wells. Standard safe offset distances will be applied to these features. McFaddin NWR staff also indicated that there is an existing electrified fence along the shoreline of the Gulf of Mexico that may be within the project area and require avoidance. In addition, hunting and other informational signs would need to be avoided by project activities.

Access has also been determined in McFaddin NWR. McFaddin NWR staff requested that access for project equipment originate from existing boat landing areas along the northern or eastern shore of Clam Lake. Alternatively, the boat ramp located along Perkins Levee could be used; however, prior authorization would be required from McFaddin NWR. This prior authorization would need to include information outlining the type and frequency of equipment use prior to utilization of this structure. McFaddin NWR staff also requested that existing hurricane "blowout" areas be used along Five-Mile Cut (west of the proposed seismic survey line) to access the proposed project and that the amount of equipment passes be overlapped and minimized during operations. These features will be identified and located in the field during hazard and access surveying.

3.9 SOCIOECONOMIC RESOURCES

The proposed project area encompasses land within Jefferson County. The communities of Sabine Pass and Port Arthur are the largest population centers closest to the project area within the project vicinity. The communities of High Island and Winnie are smaller communities within 20 miles of the project site. Information on population, major industries, labor force, unemployment rate, leading employers, housing units, and median home values for all three counties is provided here.

According to the U.S. Census Bureau, the population of Jefferson County was 252,273 persons, 222 persons over the 2000 census of 252,051 (0.1% increase) (U.S. Census Bureau, 2012a). Populations projections in Jefferson County are 276,051 for 2020 (TSDC, 2012). The largest population centers in Jefferson County are Beaumont and Port Arthur with populations of 118,296 and 53,818 in 2010, respectively (US Census Bureau, 2012b).

The labor force in Beaumont-Port Arthur Metropolitan Statistical Area (MSA) was estimated at 184,900 in February 2012 (BLS, 2012a). According to the Bureau of Labor Statistics, Jefferson County had an unemployment rate of 10.8% in February 2012 (BLS, 2012b). The major employment industries in the county include construction, mining, quarrying and oil/gas extraction, agriculture/forestry/fishing and mining, and food services (City-Data, 2012).

In 2010, there were 104,424 total housing units in Jefferson County. In 2010, the median value for owner-occupied housing units was $88,400. The median household income in 2010 was $42,293 (US Census Bureau 2012a). The 2012 poverty guidelines for a family of four is $23,050 (DHHS, 2012).

4.0 ENVIRONMENTAL CONSEQUENCES

4.1 OVERVIEW

The following description of potential impacts of seismic operations and how avoidable impacts are eliminated and unavoidable impacts minimized, restored, and/or mitigated through USFWS management of seismic operations through the issuance of the SUP is derived primarily from USFWS management of previous seismic operations on coastal NWRs in Texas and Louisiana.

For purposes of the impact assessment for the “No Action Alternative” (USFWS not issuing a SUP for the proposed project), the USFWS assumes that GXT would elect to proceed with its seismic survey project without a SUP, relying upon the property rights of the underlying mineral interest owners to make reasonable and necessary use of the surface to explore for and develop their mineral interests.

Outlined below are the predicted impacts (direct, indirect, and cumulative) that could result from implementation of each of the two alternatives. Some effects will be common to both alternatives; whereas, others would be distinctly different. Since the seismic survey would occur under both the Proposed Action and No Action Alternatives, many of the potential impacts would be similar; however, the duration, range, and intensity of the impacts will differ between

alternatives. Direct, indirect, and cumulative effects common to both alternatives are addressed in Section 4.2, and effects specific to each alternative follow in Sections 4.3 (Proposed Action) and 4.4 (No Action).

Cumulative Impact Analysis is required by NEPA and the Council on Environmental Quality regulations. CEQ's definition of cumulative impacts is as follows:

> *"…the impact on the environment which results from the incremental impact of the action when added to other past, present and reasonably foreseeable future actions regardless of what agency (Federal or nonfederal) or person undertakes such other actions. Cumulative impacts can result from individually minor, but collectively significant actions taking place over a period of time" (40 CFR 1508.7).*

The following **Sections 4.1.1 through 4.1.4** include past, present, and proposed oil and gas related actions within the project area, which were taken into account when assessing cumulative impacts to Refuge resources.

4.1.1 Previous Seismic Surveys

Seismic surveys have occurred within the project area in the past, both before and after lands were acquired for the McFaddin NWR. The most recent seismic survey in the Refuges was conducted by Suemaur Exploration & Production, LLC (Suemaur) in 2006. Suemaur conducted the seismic survey on the western portion of McFaddin NWR, the eastern portion of ANWR, and on the private lands located in and around the Refuges. One other known seismic survey that occurred within the western portion of McFaddin NWR and the surrounding private lands was conducted by Veritas DGC. The seismic operations were conducted across two thirds of the McFaddin NWR from the east end extending to the west. The seismic surveys were conducted under a USFWS SUP, which required strict adherence to stipulations that protected and minimized impacts to the human environment. Seismic equipment utilized during most surveys included marsh masters (light weight tracked equipment), airboats, airboat drills, lightweight aluminum marsh buggy drills, and highland drill rigs, where appropriate. The majority of the impacts resulting from these project operations can be attributed to the compression of soils and/or temporary changes in plant communities within the various habitat types on the 2D line.

Fairways' Monroe City 3D, Phase I and Phase II operations overlap the Middleton Ranch 3D Amendment Area (see below), but not on the Refuge properties. Phase III of the project encompassed some lands within the ANWR and McFaddin NWR. Fairways' project included hole depths of 80 feet with 2.2 to 5 pound charges on land, and 7.7 lbs at 110 ft and/or airguns in water. Additionally, the Fairways project design incorporated more densely spaced source holes (165 ft) and lines (1,650 ft), as well as receiver point locations (165 ft) and lines (990 ft), which will cause additional impacts to resources within the project area.

Currently, Samson Energy Company (Samson) is conducting the Middleton Ranch 3D Amendment Area Seismic Survey which encompasses the western portion of the McFaddin NWR, but outside of the project area identified in GXT's GOM LithoSpan Phase I 2D survey

area. This project is being conducted in combination with the Bolivar 3D Seismic Survey and both projects together are referred to as West Willow Phase II 3D Seismic Survey. Operations within the Refuge Complex commenced on April 15, 2012, and are ongoing. This seismic survey is being conducted under a USFWS SUP, and is also required to strictly comply with stipulations that protect and minimize impacts to the human environment. Similar equipment is being used on this project as that proposed by Suemaur. Close coordination is being conducted with the Texas Chenier Plain Refuge Complex staff, and SafeTeam monitors to ensure all USFWS stipulations are being adhered to.

The effects of soil compression in intermediate, brackish, and salt marshes can have negative effects when combined with other man-made actions (channelization through man-made ditches, the dredging of the GIWW, etc.) and natural processes (hurricanes pushing saltwater inland). The changes in marsh elevation through soil compression on the 2D line can allow saltwater intrusion deep into these marshes through various man-made actions or natural processes. Saltwater intrusion can stress or kill many marsh plant species and when combined with a tidal exchange, leads to erosion and further deterioration of intact marshes and loss of vegetated habitat to open water habitat, if not properly mitigated. Marsh management with either a man-made or natural levee system, water control structures, and/or a source of freshwater inflow will often allow these actions to be mitigated. A marsh without a system of surrounding levees, water control structures, and the ability to mitigate the actions will potentially suffer the effects of saltwater intrusion and further degrade the long-term health of the marsh environment. The projects that have operated under the USFWS SUP stipulations have reduced some of the impacts from these actions, when strictly adhered to. The actions of past, present, and reasonably foreseeable future seismic surveys conducted under a SUP, when added to the other man-made actions and natural processes, could have negative cumulative effects in some marsh habitat types. GXT will minimize the likelihood of saltwater intrusion and negative cumulative effects through the use of lightweight equipment best suited to the habitat present within the project area.

4.1.2 Previous Exploratory Drilling

Exploratory drilling has occurred within the project area in the past, both before and after lands were acquired for the McFaddin NWR, as well as on the private lands surrounding the McFaddin NWR. There are no records of past exploratory drilling operations available to the Refuge, since the acquisition of property on the west end of McFaddin NWR beyond the original acquisition, which took place in 1980. Additions to the west end of McFaddin NWR have occurred in 1995, 1996, and the most recent in 2005. The land acquisitions in 2005 had also led to inheriting existing oil wells on the west end of McFaddin NWR that are currently in production.

Exploratory drilling actions result in one of two outcomes, these being production of the well, when oil and gas reserves are discovered or what is termed as a “dry hole” requiring plugging and abandonment of the drilled well, when oil and gas reserves are not discovered. Past exploratory drilling actions within the project area have led to some production actions within the ANWR, Moody NWR and McFaddin NWR and on the surrounding private lands, as well. These production actions will last as long as the oil and gas reserves can be feasibly extracted. Stipulations within McFaddin NWR require written notification within one year of the shut-in of

any producing well. The notification must also provide the plans for a well recompletion to produce the well again or plugging and abandonment to cease all activities. The recompletion or plugging and abandonment of a well must occur within 90 days of the notification, as required by the McFaddin NWR SUP. Whether plugging and abandonment has occurred as a result of a dry hole or at the cessation of production of the well, the actions that have occurred under the stipulations of the SUP, requiring the impacted site to be restored to its pre-existing conditions and plant communities, has reduced the cumulative effects of exploratory drilling within the Refuge Complex.

4.1.3 Previous and Present Production

Oil and gas production has occurred within the project area in the past, both before and after lands were acquired for the McFaddin NWR. The oil and gas leases within the project area have exchanged ownership over time. Historically, the major companies were involved with the production actions on these leases and eventually sold off the leases to smaller companies over time, as production decreased within the leases. The oil and gas operations that have not operated under the McFaddin NWR SUP have contributed to cumulative effects of oil and gas actions on the human environment.

The project will cross an existing 4.5 inch natural gas pipeline that is managed by Papco, Inc. as part of the Clam Lake Gas Gathering System. There are 10 existing shared bottom and surface wells within 1 mile of the proposed project. The closest wells are located approximately 559 feet to the east and 858 feet to the west of the proposed project. There are numerous well pipelines and gathering lines located within the project vicinity, mainly to the east of the project near the Clam Lake Field. None of the production infrastructure within this field would be affected by project activities.

Over time, the oil and gas industry has been able to utilize new technology that has led to increased protection of the environment and reduced impacts to sensitive environments, where practical. The use of directional drilling has allowed drilling operations to occur from areas that have been previously impacted, close to existing roads, or even in areas less sensitive to the impacts. The use of impermeable liners under the drilling equipment has provided a barrier against contamination of soil and ground water. The use of a closed-loop system for capturing drilling mud and cuttings and having them properly processed and disposed of in a State-approved facility has provided protection against soil and water contamination from chemicals and heavy metals, when compared to the open pits that were utilized in past oil and gas drilling operations. Technological advancements have occurred over time in the oil and gas industry and have been implemented into the McFaddin NWR SUP over time, to help protect the human environment.

Any future production actions that are conducted under a McFaddin NWR SUP will have to adhere to stipulations that protect and minimize impacts to the human environment including, but not limited to, the required use of catch pans under equipment to minimize contamination to soils and water, the use of hospital muffler systems on engines and compressors that substantially reduce noise pollution and disturbance impacts, the requirement for the burial of all gathering pipelines between wells and production facilities that reduce exposure to the environmental

elements and reduce the chances of an oil spill. These stipulations, as well as others attached to the SUP, help to protect the human environment. The reasonably foreseeable future production actions that operate under a NWR SUP could have short-term (the life of the well) cumulative effects on the human environment. These operations will pose the least threat to cumulative effects, due to stipulations in the NWR SUP, that require the site to be restored to its pre-existing conditions, so that it can once again function as wildlife habitat in the future.

4.1.4 Proposed Actions

Within the project vicinity, Samson initiated in late 2011 some preliminary discussions with the McFaddin NWR for a proposed oil and gas well pad prospect adjacent to the Perkins Levee (Kingfisher #1 Prospect). Additionally, they have discussed with the McFaddin NWR another potential oil and gas well pad prospect along the western shoreline of Star Lake (Pedazzo Prospect). Both of these project discussions have been preliminary and, at this time, there are no plans for construction of these projects. It is possible, depending on market conditions, that these prospects will be reinitiated in the future.

In 2009, Ayco Energy Partners (Ayco) proposed two well pads located within the McFaddin NWR in close proximity to the Kingfisher #1 prospect outlined above. Ayco prepared a Draft Environmental Assessment (EA)/Special Use Permit (SUP) in association with the proposed project; however, the EA/SUP was never finalized. It is possible that this project would be reinitiated in the future.

4.2 EFFECTS COMMON TO BOTH ALTERNATIVES

This section assesses the common environmental impacts of implementing either of the two alternatives on the biological, physical, social, economic, cultural, and historic resources of the Refuges.

4.2.1 Geology and Soils

The McFaddin NWR consists primarily of wetland areas. Soil compaction and/or rutting that might result from the movement of heavy equipment in sensitive wetland and transitional habitats in the McFaddin NWR is a primary concern because slight changes in ground elevation can result in pronounced changes in habitat in coastal marsh. For example, water ponding in depressions, resulting from equipment-caused soil compaction, could change species composition of the vegetation within these depressions. Additionally, rutting could lead to more rapid drainage and drying of marsh soils. Hydrological impacts, specifically those that might cause saltwater intrusion and increased tidal energies, can, in extreme situations, result in marsh loss (conversion of vegetated marsh to open water). These potential impacts are discussed in **Section 4.2.3**. It is likely that some degree of soil compaction and/or rutting in wetland and transitional habitats from normal seismic operations will be unavoidable, and some damages would occur in locations where restoration will not be possible.

Hydrogeological impacts resulting from soil compaction, specifically impeding the recharge of near surface water tables, would likely be minimal or non-existent on the McFaddin NWR.

In uplands or dry-land drilling, excess cuttings from the drilling may exist at some shot hole locations. The excess soil remaining varies, but averages less than two cubic feet per shot hole. Normal procedure is to backfill the shot holes with the drill cuttings, but the degree to which the immediate shot hole area is restored is operator-dependent. Holes would be plugged in accordance with Railroad Commission of Texas Rule 3.100 for the prevention of commingling of surface and ground water, and any remaining cuttings would be spread in a thin layer around the hole. Bare ground or unvegetated topsoil created by the excess soil cuttings can provide favorable conditions for seed set and growth of invasive species such as the exotic Chinese tallow.

4.2.2 Hydrology and Water Quality

The impacts of the proposed seismic survey upon water can be categorized as effects on quality of surface water, effects on quality of groundwater, and effects upon water volume due to use in shot hole drilling operations. Generally, the quality of surface water in the vicinity of the seismic survey will not be impaired by the seismic activity. However, surface waters of shallow or ephemeral ponds and marshes may be impacted by short-duration, localized increases in turbidity due to the activity of airboats and drilling equipment. While temporary and localized, increased water turbidities during the growing season could reduce production of submerged aquatic vegetation in those areas affected. McFaddin NWR staff have requested that if airboats are used in Five-Mile Cut near the Perkins Levee, that coordination is done prior to operations as there is submerged aquatic vegetation present that may be adversely affected. Some aquatic plant species, such as water-shield, react poorly to increased turbidity.

The groundwater protection depth for Jefferson County varies depending on location. The stated depth of shot holes for the proposed project will be 80 feet within the McFaddin NWR. GXT submitted a request for a seismic letter of ground water protection from the Railroad Commission of Texas (RRC), which will outline recommended groundwater protection measures. The RRC letter was approved on April 19, 2012, and is included in **Appendix D**. The GXT will comply with recommendations provided in the letter. The drilling of shot holes will require minimal quantities of water, which will have negligible impact to surface water quantities within the McFaddin NWR.

4.2.3 Vegetation and Habitat

Vegetation in the project area will be affected primarily by mechanized equipment traffic along the shot and receiver locations (traffic swaths), and locally at each shot hole location. Some vegetation will be cleared or crushed by equipment access, drilling, and water pit excavation.

Some unavoidable soil compaction and rutting from equipment passes along the 2D line can be reasonably expected to occur due to seismic operations occurring in wetland and transitional upland habitats within the project area. Subsequent increases in water depths and inundation periods along the compacted 2D line would likely cause changes in plant species composition. In cases of severe compaction or rutting, altered hydrological conditions may favor establishment of invasive plants such as cattail and common reed. Compaction could also

increase the potential for saltwater intrusion within freshwater habitats. Prolonged intrusion would result in a loss or reduction of freshwater species and establishment of those that are salt-tolerant. Furthermore, severe compaction or rutting could increase saltwater intrusion by leading to the creation of new channels established by erosive forces of tidal water exchange over prolonged periods of time.

Any such impacts from seismic survey activities would likely be manifested over a long-term period of several years after the survey is completed. Saltwater intrusion into coastal freshwater marsh systems (like those within the project area) can cause extensive plant mortality and erosion of highly organic marsh soils, thereby leading to marsh loss (the conversion of vegetated emergent marsh to open water). Marsh loss resulting from saltwater intrusion, land subsidence, sea level rise, and other factors is a major problem affecting coastal marsh ecosystems along the upper Texas Gulf Coast (Moulton et al., 1997). Tidal marshes in the McFaddin NWR are particularly sensitive and susceptible to marsh loss.

The deposition of drill cuttings could damage or kill vegetation immediately surrounding shothole locations and potentially affect the hydrology of the area, which could in turn affect vegetation. The introduction and/or spread of non-native/invasive species also has the potential to adversely impact vegetation, as these species could out-compete native species and change the characteristics of the vegetation in localized areas. Areas accessed by equipment have the greatest potential for this to occur.

Pressure waves resulting from detonation of charges in shotholes could potentially affect vegetation root systems and/or aquatic vegetation, both submerged and emergent. The majority of lands within the project area would be considered wetlands, and soils in the area are very poorly drained and have a very shallow water table. Based on this information, vegetation root systems are expected to be shallow and are not expected to extend to great depths. Charges would be detonated 80-100 feet below the surface, well beyond the level of vegetation root systems, and pressure attenuates out from the source, decreasing toward the land surface; therefore, no negative impacts on tree roots are expected from the detonation of charges in deep holes.

Data on the effects of explosives on aquatic plants is very limited. Ludwig (1977) described removal of eelgrass (*Zostera marina*) by firing single charges and detonation cord underwater during channel construction at the Niantic Estuary at Waterford, Connecticut. During an 8-week period following the explosions, eelgrass defoliation occurred within a radius of approximately 3.5 to 4 m from each single charge. Defoliation occurred within a 1 to 2 m zone along the length of the detonation cord. No information was reported concerning the weight or type of explosives used.

Examination of the eelgrass indicated defoliation occurred as a result of internal cell wall failure, while plant epidermal fibers continued to hold the plant structure together. Further, it was observed that green algae (*Codium* sp.) and rockweed (*Fucs* sp.) in the zone of defoliation suffered no apparent impacts following the explosions.

Explosives to be used during the seismic survey will be placed in drill holes at least 80 ft below

ground surface or water bodies and will be confined by bentonite backfill in accordance with agency requirements. Consequently, emergent and submerged plant species will be exposed to substantially lower pressure waves than if detonation was to occur at the surface or underwater at the water body floor. Explosions associated with the seismic survey are not anticipated to have measurable adverse impacts to either aquatic or terrestrial plant species.

4.2.4 Fish and Wildlife

The abundant and diverse vegetation of the project area provides habitat for a variety of species of wildlife. Activities associated with GXT's proposed 2D survey may directly or indirectly affect wildlife that reside in or migrate through the project area. Proposed operations would potentially affect both terrestrial and aquatic habitat, as well as directly disturb and possibly attract wildlife.

Noise from drilling equipment, support vehicles, helicopters, detonation of charges, and the presence of crews could temporarily displace wildlife into adjacent habitat and/or temporarily alter the normal behavior of certain species.

Seismic survey activities are of a degree of intensity such that it is likely that use of McFaddin NWR habitats by migratory birds, including waterfowl, shorebirds, wading birds, and songbirds would be temporarily reduced within localized portions of the project area, especially in the immediate area of the drilling of shot holes, laying out and picking up of receiving equipment, and recording activities that involve concentrated periods of mechanized equipment use in localized areas. These disturbances could displace migratory birds, at least temporarily, to adjacent habitats, but in some cases, the quality of these alternative habitats may be lower. It is anticipated that these disturbance impacts would be short-term and temporary.

The proposed seismic survey could, but not likely, overlap with the early fall migration of certain waterfowl, primarily teal and several shorebird species, which can be present in large numbers on the McFaddin NWR during this period. However, activities should be restricted to recording operations, which occur within narrow, but shifting swaths, leaving large areas of suitable, undisturbed habitats available in other portions of the McFaddin NWR. Disturbances caused by seismic survey activities conducted later in the fall could alter use patterns by much larger concentrations of migratory waterfowl and other wetland-dependent birds over a larger area and for a longer period of time. As outlined above, operations are not anticipated to occur in the fall due to the limited duration of time within the McFaddin NWR (2 months maximum).

The initial and final phases of the proposed seismic survey may overlap with spring and fall migration of several species of raptors including the Arctic peregrine falcon. Peregrine falcons migrate through the Refuge Complex during these periods, and are occasionally present within the McFaddin NWR in low numbers during winter. This species may be displaced by seismic survey activities, but is highly mobile and displacement would likely be only temporary.

The mottled duck is a resident waterfowl species which nests and rears young on the McFaddin NWR and within the project operations area. Peak nesting of this species in the region occurs in March, April, and May (Stutzenbaker, 1988), but later nesting and re-nesting does occur

throughout the summer. In some cases, disturbance from seismic survey activities could result in reduced nesting success for mottled ducks and other nesting birds (through possible nest abandonment or increased susceptibility to nest predation). Adult mottled ducks generally complete their molt by late August. During their molt, they are flightless and more susceptible to disturbance. Immature or flightless birds could be disturbed and displaced by seismic survey operations, which could make them more susceptible to predation and other sources of mortality. Shotholes would avoid any mottled duck nests observed within the project corridor.

The project area also contains potentially suitable habitat for colonial water bird rookeries, which have historically been known to occur within the McFaddin NWR. Most rookeries are not stationary and may shift seasonally. Nesting success of colonial water birds could be affected by disturbances resulting from operations.

The seismic survey's impact on resident wildlife in the project area will primarily be short-term. In general, habitat exists for wildlife to emigrate from the immediate vicinity of the proposed operations to similar adjacent habitats, which will be unaffected by project operations. Small mammal, amphibian, and reptile populations may experience some local loss of individuals and change in species composition for a short time due to their limited mobility and ability to avoid project equipment and activities. These local losses are not expected to affect population size or stability, and individual losses will be replaced over several generations of each population. Nests of small animals or bird species may be impacted along equipment access routes, and ground dwelling species may be negatively impacted by soil compaction resulting from equipment travel and/or drilling activities. Larger mammals are more mobile and will be capable of avoiding the seismic survey operations.

Alligators nest within the project area. There is the potential that nests could be impacted by operations as a result of equipment travel through the area; however, any nests discovered would be clearly flagged for avoidance and operations would be offset away from the nests for their protection. Based on the size and depth of the charges to be used during the proposed seismic survey and the fact that source points would be offset away from alligator nests, detonations are not expected to negatively impact nesting alligators, egg viability, or nesting success.

There is the potential that aquatic species could be taken up in the hoses through which water is drawn for drilling purposes, causing mortality of aquatic species. Additionally, fish, other aquatic species or their eggs within the project area could be affected by the shock wave from close proximity energy source detonation. Fish with swim bladders have a greater likelihood of experiencing mortality than those without air-containing organs. Most terrestrial animal species that occur within the project area are not likely to experience any negative impacts from seismic detonations; however, some terrestrial species within the project area are considered to be aquatic in nature. These include some species of mammals but more commonly, reptiles and amphibians. Keevin and Hempen (1997) indicated that in 1997 there was no single comprehensive study to determine the effects of open water explosions on either amphibians or reptiles, which defines the relationship between distance/pressure and mortality or injury. A number of studies demonstrate that sea turtles can be killed or injured by underwater explosions (Duronslet, et al., 1986; Gitschlag, 1990; Gitschlag and Herozeg, 1994; Gitschlag and Renaud,

1989: Klima, et al., 1988; O'Keefe and Young, 1984). For this report, no information was found which discusses the impact of confined, subsurface explosions on reptiles or amphibians.

Although untested, reptiles and amphibians with air-containing organs, such as lungs, probably have mortality comparable to fish with swimbladders (Keevin and Hempen, 1997). For impact assessment purposes, the relationship between distance/pressure and fish mortality/injury are probably similar. Further, amphibians without air-containing organs may be relatively immune to underwater explosions as are benthic fish species without swimbladders (Goertner et al., 1994). Explosives placed in drill holes and adequately stemmed produce significantly less impact than open-water explosions (Keevin, 1997). Based on the size and depth of the charges to be used during the proposed seismic survey, no impacts from explosions are expected to occur to aquatic reptiles and amphibians. Further, the potential impacts of the confined, subsurface explosions to terrestrial reptile and amphibian species are expected to be insignificant.

DESCO has monitored several projects in which holes were drilled and detonated in open water environments in order to assess impacts to fish and other aquatic species. Aside from the hole depth and charge size, water depth and bottom substrate are the two factors that seem to have the greatest effect on impacts. Generally, the deeper the water, the lesser the number of fish/aquatic species impacted. When conducting operations in shallow water, fish/aquatic species can scare easily, so very few, and potential impacts to these species are minimized or avoided. Utilizing scare tactics like circling around the hole and/or banging on the bottom of the boat helps to ensure that fish/aquatic species move out of the area. Generally, the harder the bottom, the greater the number of fish/aquatic species impacted. You will likely get more impacts in areas with hard, sandy bottoms than in areas with muddy or mucky bottoms because the energy that is released into the water column through harder substrates is more concentrated than in areas that allow for more movement/distribution of the energy through sediments. Fish mortality has been observed during DESCO's monitoring efforts; however, mortality of other aquatic species has not been observed. This can either be explained by the fact that other aquatic species were not present in close enough proximity to the hole to be affected at the time of detonation and/or the species are not affected as greatly as fish species are by subsurface detonation in open water environments.

Water depths within the majority of the project area are very shallow, as they are associated with emergent marsh systems (< 2 feet), with the exception of the GIWW and Five-Mile Cut. In addition, pressure experienced in the water column near to the shot hole within the McFaddin NWR should be minimal, as the substrate in the area should allow for some dissipation of the energy wave due to the loose nature of the sediments present.

Previous studies conducted in open water habitats near the McFaddin NWR were conducted in October 2010 in association with an unaffiliated seismic project at Lake Anahuac, Texas. The purpose of the study was to closely examine pressure levels in the water column near the shot hole. These tests were done at charge depths greater than that proposed by GXT. Water depths for the test shot hole locations averaged 2 m.

These tests were conducted by lowering a pressure phone 1 m below the surface of the water and measuring the pressure levels in psi and decibels (dB) re 1 µPascal (µPa) from different charge

sizes (11 lb, 5.5 lb, and 3.3 lb) at different offset distances (m). Based on the results of the tests, pressure in the water column dissipates quickly as one moves away from the source point location. A detailed table and analysis of this is available in the Middleton Ranch EA/SUP for Samson Lonestar, LLC (USFWS, 2012b).

4.2.5 Federally-and State-Listed Threatened and Endangered Species

Several species are federally-listed as threatened or endangered within the project area; however, some species, such as the Sprague's pipit, smalltooth sawfish, and the red wolf are either not known to occur in or have been extirpated from the project area. Other species, such as the American and Louisiana black bears, Rafinesque's big-eared bat, southeastern myotis bat, all state-listed species of mussels in Jefferson County, northern scarlet snake, Sabine map turtle, Texas horned lizard, timber/canebrake rattlesnake, and Chapman's orchid are not expected to occur within the project area because suitable habitat for these species is not present within the McFaddin NWR. The remaining species, discussed below, have been known to or have the potential to occur on the McFaddin NWR or near the McFaddin NWR.

Federally-Listed Species
Piping plovers (threatened) are known to occur within the project area and they could be present along the Gulf coastline of the McFaddin NWR and any intertidal mudflats along the GIWW during project operations. The proposed project issued under a SUP includes an approximate 1,000-foot buffer seaward from the Gulf of Mexico shoreline and 600 feet landward of the dune line to assist in avoiding adverse effects to this species. In absence of dunes, the demarcation line would be the vegetation line closest to the beach. Though not anticipated, piping plovers may be temporarily displaced from or interrupted in their habitats by seismic survey activities. This temporary interruption may have some effects on the plover's time and energy budgets; however, this species is also highly mobile, can easily avoid direct impact by seismic activities, and is not likely to be adversely affected by project activities. The environmental monitors will be alert for the potential occurrence of these birds and will work with the McFaddin NWR Manager and seismic contractor(s) to minimize disturbance, as much as feasible.

Threatened or endangered sea turtles (listed in **Table 15**) occur in the Gulf of Mexico and coastal waterways, both of which occur adjacent to the project area. While sea turtles may utilize waters in the GIWW, they only land themselves along the Gulf coastline. Sightings of nesting or stranded turtles along the Gulf will be immediately reported to the environmental monitors and McFaddin NWR Manager and the immediate area will be avoided until approval has been granted by the McFaddin NWR Manager to proceed with operations. Operations within 1,000 feet seaward of the Gulf of Mexico shoreline and 600 feet landward of the dune line will assist with avoiding potential effects to turtle nests and individuals during operations, as outlined in the SUP. This being the case, threatened or endangered sea turtles would not likely be adversely affected by project activities.

State-Listed Species
The Arctic and American peregrine falcons are migratory transients to the project area. No known nesting locations occur within the project area. There is the potential for minor temporary behavioral disturbances to this species during falcon resting periods within the

McFaddin NWR if they are in the proximity of project operations; however, disturbance would be short-term, minimal, and limited to areas of operation.

Bald eagles are known to be transient through the McFaddin NWR, but are not known to nest there. Feeding by bald eagles may occur within the project vicinity and area, depending on site conditions, carrion present, and food resources available to this species. Feeding behavior may be temporarily disturbed during operations; however disturbance would be short-term, minimal, and limited to areas of operations. There is a multitude of adjacent suitable habitat available for feeding.

Brown pelicans are also known to be transient through the McFaddin NWR, but are not known to nest there. Feeding by brown pelicans may occur within deeper water habitats within the project area (GIWW, Five-Mile Cut), but is not anticipated to occur within marsh areas with shallow water levels. Brown pelicans may be found loafing/resting within the GIWW and other deepwater habitats. Feeding and loafing/resting behaviors may be temporarily disturbed by project operations within the project area; however, disturbance would be short-term, minimal, and limited to areas of operations.

Since seismic survey activities are not likely to adversely affect any federally and/or state-listed threatened or endangered species, potential impacts to threatened or endangered species would not differ between the two alternatives. However, completion of the seismic survey under the USFWS-issued SUP would result in an increased probability that the presence of a threatened and/or endangered species on the McFaddin NWR during the course of seismic operations would be documented, and would provide an opportunity to alter operations to minimize or avoid disturbance and displacement of these rare species.

Cumulative Effects

The cumulative effects discussion below is only related to cumulative effects in regards to the definition as outlined by the National Environmental Policy Act (NEPA). Cumulative effects on threatened, endangered, and rare species within the project area are known to have occurred and could possibly continue to occur because of oil and gas actions, man-made actions, and natural processes, primarily outside the boundaries of USFWS lands. Several species of wildlife have been extirpated from the project area over time, some of which include the red wolf and the smalltooth sawfish.

The McFaddin NWR provides habitat and protection for threatened, endangered, and rare species, contributing to beneficial cumulative effects within the project area. Projects proposed and conducted within USFWS lands, with or without a SUP, would be subject to compliance with the Endangered Species Act (ESA) and other laws, regulations, and policies that provide protection for these species. GXT will incorporate several measures into operations to minimize the likelihood of encountering threatened, endangered, or rare species and will take protective measures if any are encountered; therefore, operations are not expected to contribute to cumulative effects on those species, when combined with other past, present, and future actions. There would not be any differences in cumulative effects to threatened, endangered, or rare species between the two alternatives, as the survey would be conducted under each of the

alternatives in compliance with the ESA and other laws, regulations, and policies that provide protection for these species.

4.2.6 Historical and Archeological Resources

Most of the impact from the proposed seismic survey will be related to surface disturbance. Such disturbance on the McFaddin NWR will be limited to airboats, limited use of highland track drills and water vehicles, and drilling of seismic shot holes. All other vehicular traffic will be limited to existing roads and levees. Subsurface disturbance from the drills will be limited to the approximately 4 in hole drilled at each shot hole location.

The cultural resource avoidance plan (**Appendix A**) identifies the proposed low impact seismic methodology, buffer zones of 50 m around all known cultural/historical sites, avoidance of high probability areas unless a cultural resources survey is conducted and any sites discovered as a result are avoided, and procedures that will be followed in the case of inadvertent discoveries. These measures will be followed throughout the entire seismic survey area, both on and off the McFaddin NWR; therefore, impacts to cultural and historic resources should not differ between the two alternatives. However, the daily oversight of seismic program activities provided by the USFWS and environmental monitors under the Proposed Action should provide a higher level of protection of known sites and high probability areas, as well as timelier reporting and protection of any inadvertent discoveries of cultural or historic artifacts or other resources.

Cumulative Effects

Cumulative adverse impacts on cultural/historic resources within the project area have occurred and will continue to occur as a result of natural erosion and decomposition, development including oil and gas, and recreational activities. Impacts to historical and archaeological resources have occurred within the project area in the past, both before and after lands were acquired for the McFaddin NWR. Seismic activities require large scale operations over a vast area. The operations utilize airboats and tracked and rubber tired equipment, which can impact cultural and historic resources. The operations drill holes to set charges and detonators, which can also impact historical and archaeological resources. Exploratory drilling activities require construction of board roads and drill pads and drilling of the well. These activities, although localized, can impact historical and archaeological resources as a result of surface disturbance that is required to conduct operations. Production activities may require excavation for installation of pipelines, as well as construction of production facilities, both of which could cause surface disturbance, potentially affecting historical and archaeological resources.

The McFaddin NWR provides habitat and protection for historical and archaeological resources, contributing to beneficial cumulative effects within the project area. Projects proposed and conducted within USFWS lands, with or without a McFaddin NWR SUP, would be subject to compliance with the Historic Preservation Act and other laws, regulations, and policies that provide protection for these resources.

Because GXT's proposed operations are not expected to encounter, and thus affect, historical or archaeological resources, the operation should not contribute to cumulative effects on those resources, when combined with other past, present, and future actions.

There would not be any differences in cumulative effects to historical and archaeological resources between the two alternatives, as the survey would be conducted under each of the alternatives in compliance with the Historic Preservation Act and other laws, regulations, and policies that provide protection for these resources.

4.2.7 Land Use

Approximately 90,000 people visit the McFaddin NWR annually for recreational and educational activities including fishing, waterfowl hunting, wildlife observation and photography, canoeing and kayaking, crabbing, hiking, environmental education and interpretation, and beach-related recreation.

Waterfowl hunting occurs on the Refuges in designated Public Hunting Areas during state specified seasons, and includes the September early teal season. Alligator hunting also occurs on the Refuges in September. Assuming the project is approved by the USFWS by July 2012, the project activities are not anticipated to affect teal or alligator hunting seasons in September. If it is determined that the project would be in conflict with the hunting seasons, project operations would be coordinated with the McFaddin NWR Manager. There is currently no other hunting that occurs on the Refuges until after the October 15 (no work occurring on the Refuge) period.

Management activities to enhance, restore, and protect habitats for migratory birds and other native fish and wildlife species on the McFaddin NWR include water level salinity management, prescribed burning, invasive plant species control, and controlled grazing. Water management infrastructure includes water control structures (culverts), levees, ditches, and canals. All alterations to fence lines will be repaired to their original condition before termination of seismic operations. Other infrastructure such as levees and cattlewalks damaged by the seismic operations will be repaired to their original condition.

Operations conducted under each of the alternatives have the potential to interfere with public use of the McFaddin NWR. Crew presence and noise may impact visitor experiences and/or cause the public to perceive that the McFaddin NWR is not a desirable place to visit. Operations could also interfere with hunters if operations are conducted during the hunting season. These disturbances would be short-term, minimal, and limited to areas of operations.

Cumulative Effects

Cumulative impacts on land use within the project area and surrounding areas have occurred and would continue to occur because of visitor use, hunting, development including oil and gas operations, and other Refuge-approved projects/activities. Land use impacts have occurred within the project area in the past, both before and after lands were acquired for the Refuge Complex. The installation of roads and well pads within the project vicinity has resulted in the conversion of wetlands to uplands to access infrastructure. This conversion of land use has contributed to both adverse and beneficial cumulative effects.

The installation of roads and well pads across uplands and wetlands has led to adverse cumulative effects through negative impacts to sheet flow, affecting hydrological function, and

thus potentially affecting plant communities and habitats. The access roads also fragment habitat and lead to disturbance impacts to wildlife by allowing access that was once not available. The installation of roads and well pads has also led to beneficial cumulative effects by providing access into the McFaddin NWR for refuge administrative uses and visitor uses. The access roads provide refuge employees with the means to conduct biological surveys and complete maintenance requirements to effectively manage the natural resources. The access roads provide for management activities such as cooperative grazing that benefit wildlife uses on the refuge. The access roads also provide a means for visitor uses such as wildlife observation, wildlife photography, fishing, hunting, and educational opportunities. The access roads and well pads provide suitable habitat to some species of wildlife that require elevated areas for daily life functions. Some avian species benefit from the elevated areas with gravel substrates for nesting habitat. The elevated areas also promote growth of brush species that in turn provide nesting and foraging habitat to animal species that utilize these habitats.

GXT's operations, conducted under either alternative, are not expected to contribute to cumulative impacts on land use in the project area due to the fact that impacts would be short-term (limited to the duration of seismic activities) and localized to the areas in which crews are working.

4.2.8 Socioeconomics

The proposed seismic exploration project would provide the local communities closest to the McFaddin NWR (Sabine Pass and Port Arthur) with short-term positive economic benefits within Jefferson County. Communities such as High Island, which is within 20 miles of the project site, may also see some residual economic benefits. These benefits would result from local spending by crewmembers or associated subcontractors on food and lodging, local purchase of supplies and fuel, and potentially, local leasing or contracting of auxiliary services. Royalties and tax revenues from oil and gas production would be realized. However, the short-term nature of the seismic operations would reduce the likelihood of most local residents being affected socially or economically because of the proposed action. There would be no difference in impacts to socioeconomic resources between Alternatives A and B.

Cumulative Effects

Cumulative impacts on socioeconomics within the project area and surrounding areas have occurred and would continue to occur because of visitor use, hunting, development including oil and gas operations, and other sources of economic development. Socioeconomic impacts have occurred within the project area in the past, both before and after lands were acquired for the McFaddin NWR. Impacts to socioeconomics could occur if declining prices of oil and gas limit the extent of seismic and exploratory drilling operations that could be conducted within the project area. The reduction in those activities may reduce any new potential production activities until higher oil and gas prices return.

The economic benefits to the local economy would be lost, causing a trickledown effect on the local economy with a possible rise in the unemployment rate in severe situations.

One beneficial socioeconomic effect common to all past, present, and future actions is that each

action provides the local communities closest to the McFaddin NWR with short-term positive economic benefits through local spending of crew per diems, local purchase of supplies and fuel, and potentially local leasing or contracting of auxiliary services. If commercial quantities of oil and gas are discovered as a result of GXT's proposed 2D seismic survey and those reserves are developed and produced, there would likely be additional beneficial cumulative socioeconomic effects on the local, regional, and national economies. If recoverable reserves are discovered, royalties and tax revenues from oil and gas production would be realized within the project area and it would also contribute to the domestic oil and gas reserves in our country.

An example of the beneficial socioeconomic effect would be residential or commercial development adding to the tax base of the area. The cumulative socioeconomic effect of future oil and gas drilling or production in the project area cannot be quantified at this time, because it is not known if the project would identify any targets of interest for exploratory drilling, and whether any exploratory wells, if drilled, would encounter commercial quantities of oil or gas.

Because impacts from GXT's proposed operations are not expected to create a measurable impact on socioeconomics within the project area, and the effect would likely end with the project, operations are not expected to add any cumulative impacts to socioeconomic values in the project area.

There would not be any differences in socioeconomic cumulative effects between the two alternatives, as the survey would be conducted under each of the alternatives, surface use fees would be paid, and crews would be present in the area making expenditures.

4.3 EFFECTS FROM IMPLEMENTING ALTERNATIVE A (THE PROPOSED ACTION)

4.3.1 Geology and Soils

The proposed operation incorporates measures that would prevent or minimize effects to geology and soils. Under this Alternative, impacts to soils and subsequent hydrological impacts would be less than under Alternative B because of the USFWS' management of the seismic operations through the SUP. Under the proposed action, GXT would use airboats and lightweight tracked vehicles to the maximum extent possible for shot hole drilling to minimize rutting and soil compaction in sensitive wetland and transitional upland habitats. To further minimize the likelihood of rutting and compaction, GXT would (1) restrict passes of mechanized equipment along the 2D line to the absolute minimum necessary, (2) offset vehicular passes along the 2D line when necessary, (3) prohibit cross-country travel by mechanized equipment, (4) require use of existing waterways, levees, and roads by mechanized equipment for access to and from the 2D seismic line, as approved by the McFaddin NWR, and (5) require distribution and retrieval of receiving equipment by foot or helicopter whenever possible.

SUP conditions will also require GXT to use pumps and hoses to provide water to the drilling site from suitable surface water sources to the maximum extent possible in order to reduce soil disturbance associated with digging pits.

GXT would restore shot hole and pit locations by completely leveling displaced soils to pre-existing surface elevations and would take special precautions when crossing waterway, pond and Gulf shorelines with mechanized equipment to minimize soil disturbance and the potential for runoff of loose soils, accelerated erosion, and sedimentation of adjacent areas.

The SUP will require restoration of all soil damages as nearly as possible to pre-existing conditions and/or mitigation for damages resulting from seismic operations. This will minimize overall impacts to soils. Where direct restoration is not possible, required mitigation would include implementation of projects, which would preclude long-term hydrological alterations (especially increased saltwater intrusion) that could result from unavoidable soil and/or vegetation damages. Examples of restoration/mitigation projects that would prevent increased saltwater intrusion include hydrologic restoration projects, restoring existing waterways to historic dimensions through construction of passive or active water control structures, restoring shorelines along existing waterways, and erosion-abatement projects along the GIWW and Gulf of Mexico shorelines.

GXT would have a trained environmental monitor(s) on site at all times during operations to serve as a daily liaison with McFaddin NWR staff, ensure provisions and stipulations of the SUP are adhered to, and to provide timely onsite guidance to seismic survey personnel in order to further minimize the likelihood of impacts to soils and other resources. GXT would also have monitors in the field accompanying crews as deemed necessary by the McFaddin NWR Manager.

Cumulative Effects

Cumulative adverse impacts on geology and soils within the project area have occurred and will continue to occur because of natural processes, recreational activities, farming operations, oil and gas operations, and off-road vehicle use. Geology and soil impacts have occurred within the project area in the past, both before and after lands were acquired for the McFaddin NWR. Exploratory drilling operations have used open pits to hold and store drilling mud and cuttings. The drilling mud and cuttings contain chemicals, heavy metals, and hydrocarbon wastes associated with drilling activities. These materials have the potential to contaminate surface and subsurface soils. The equipment utilized during drilling operations may also contribute to soil erosion, rutting, and/or compaction.

Operations conducted under the Proposed Action, combined with past and future actions and natural processes that result in similar effects, could result in soil compaction, accelerated erosion/land loss, habitat conversion, and/or contamination of soils. With incorporation of the restrictions described in **Section 2.2.7 Mitigation Measures**, the proposed action's potential to contribute to cumulative impacts will be minimized. Management of the McFaddin NWR area involved with the project is expected to help minimize impacts to geology and soils, as projects proposed within Refuge administered lands would be conducted under a SUP and designed to minimize the likelihood of impacts to resources, including geology and soils.

Because GXT's proposed operations would be conducted under a SUP, with attached stipulations that would protect geology and soils, the operation's contribution towards cumulative effects on geology and soils, when combined with other past, present, and future

actions, is expected to be low to non-existent.

4.3.2 Hydrology and Water Quality

The proposed operation incorporates measures that would prevent or minimize effects to hydrology and water quality. Under this Alternative, impacts to water resources would be less than under Alternative B because of the USFWS' management of the seismic operations through the SUP.

Under the proposed action, GXT would make necessary consideration of methods to avoid sensitive aquatic features in the laying out of the 2D line and subsequent conducting of operations along the 2D line by shifting source and receiver points to eliminate or minimize impacts to surface water quality. For example, required avoidance by mechanized equipment of small, open water wetland habitats supporting high production of submerged aquatic vegetation along the 2D line will likely minimize impacts on water turbidities and subsequent impacts to submerged aquatic vegetation.

In order to minimize the likelihood of contamination of surface or ground water from fluid leaks or spills, field oil or fluid changes will be permitted in the McFaddin NWR in only selected areas determined by the McFaddin NWR Manager. Oil absorbent pads will be required on site at all times as a precautionary measure, and any spilled oil will require immediate cleanup.

The SUP will require restoration of all soil damages as nearly as possible to pre-existing conditions and/or mitigation for damages resulting from seismic operations. This will minimize the likelihood of hydrologic modification, as well as overall impacts to hydrology and water quality. Where direct restoration is not possible, required mitigation would include implementation of projects, which would preclude long-term hydrological alterations (especially increased saltwater intrusion) that could result from unavoidable soil and/or vegetation damages.

GXT would have a trained environmental monitor(s) on site at all times during operations to serve as a daily liaison with the McFaddin NWR staff, ensure provisions and stipulations of the SUP are adhered to, and to provide timely onsite guidance to seismic survey personnel in order to further minimize the likelihood of impacts to hydrology and water quality. Overall project impacts on hydrology and water quality are expected to be negligible to minimal.

Cumulative Effects

Cumulative adverse impacts on hydrology and water quality within the project area have occurred and will continue to occur because of natural processes, recreational activities, oil and gas operations, development actions, on- and off-road vehicle use, and activities occurring in the GIWW. Water quality impacts have occurred within the project area in the past, both before and after lands were acquired for the Refuge Complex. Exploratory drilling operations have used open pits to hold and store drilling mud and cuttings. The drilling mud and cuttings contain chemicals, heavy metals, and hydrocarbon wastes associated with drilling activities. These materials have the potential to contaminate surface and ground water supplies. The equipment utilized during drilling operations may also contribute to surface and ground water contamination through spills and leaks of faulty equipment.

Production operations that require the use of chemicals to treat the produced products and/or protect against corrosion of production pipelines can contribute to surface and ground water contamination, as well, as could inadvertent leaks and spills of produced crude oil and saltwater during production activities.

Airborne contaminants could also migrate into the area, fallout (precipitate) and accumulate and settle into soils (ExxonMobil 2012)

This being said, the proposed action is not expected to contribute to cumulative impacts on habitat related to contamination, as several measures would be incorporated to reduce the potential for leaks and spills, as discussed above.

Operations conducted under the Proposed Action alternative, combined with past and future actions and natural processes that result in similar effects, could result in water pollution, hydrologic modification, habitat conversion, and/or contamination of surface or ground water. With incorporation of the restrictions described in **Section 2.2.7 Mitigation Measures**, the proposed action's potential to contribute to cumulative impacts will be minimized. Beneficial cumulative effects to water quality are expected to result from the USFWS' management of the McFaddin NWR, as the activities conducted in these areas would be subject to SUP stipulations designed to minimize impacts on water quality. Because GXT's proposed operations would be conducted under a SUP, with attached stipulations that would protect water quality, the operation's contribution towards cumulative effects on water quality, when combined with other past, present, and future actions, is expected to be low to non-existent.

4.3.3 Vegetation and Habitat

Under this Alternative, impacts to vegetation and habitats would be less than under Alternative B because of the USFWS' management of the seismic operations through the SUP.

Under the Proposed Action, equipment access routes would be chosen following a route originating from east and west of the proposed 2D line in order to minimize impacts on vegetation and habitat in both wetland and upland areas. Access routes would be subject to vegetation clearing in order to allow for the passage of equipment and crews. However, vegetation clearing would be limited to the minimum necessary to accomplish objectives, and no trees would be cut on McFaddin NWR lands.

GXT would use airboats and lightweight tracked vehicles to the maximum extent possible for shot hole drilling to minimize vegetation damage along the 2D line and decrease rutting and soil compaction in sensitive wetland and transitional upland habitats. This will minimize the potential for hydrological impacts and subsequent impacts to vegetation. To further minimize the likelihood of vegetation damage and/or habitat alteration, GXT would (1) restrict passes of mechanized equipment along the 2D line to the absolute minimum necessary (2) offset vehicular passes along the 2D line (no less than 0.5 boat width wide for airboat passes), (3) prohibit cross-country travel by mechanized equipment, (4) require use of existing waterways, levees, and roads by mechanized equipment for access to and from the 2D line and (5) require distribution,

trouble-shooting, and retrieval of receiving equipment by foot or helicopter whenever possible.

GXT would give full consideration of possibilities to avoid sensitive habitat in the laying out of the 2D line and subsequent conducting of operations along the line, as well as avoidance of sensitive habitat discovered during the course of seismic operations, by shifting source and receiver points to minimize impacts to vegetation. For example, the 2D line and operations would be shifted to avoid small stands of vegetation containing rare or sensitive plant communities such as remnant stands of native prairie and coastal woodlots. In addition, avoidance of small, natural and managed open water wetland habitats by mechanized equipment along the 2D line will likely minimize impacts on water turbidities and subsequent impacts on submerged aquatic vegetation. Crossings of waterway and wetland shorelines with mechanized equipment would be restricted to the absolute minimum necessary and special precautions would be taken to minimize vegetation damage, soil compaction, rutting, and subsequent erosional loss of marsh.

SUP conditions will also require GXT to use pumps and hoses to provide water to the drilling site from suitable surface water sources to the maximum extent possible in order to reduce plant mortality and soil disturbance associated with digging pits. GXT would restore shot hole and pit locations by completely leveling displaced soils to pre-existing surface elevations to minimize soil disturbance and the potential for invasion by nuisance invasive/exotic plant species.

There are a total of 34 pre-plot source points and 63 receivers proposed within the McFaddin NWR within the 4.0 mile linear project area. Due to the variability of the habitats present, several types of drill equipment will be used within the project area. The type of equipment and habitats present will determine the path width; however, the largest piece of equipment, the airboat drill, is approximately 14 feet wide. Assuming a 15 ft wide path along access routes, approximately 7.27 ac [4.0 linear mi x 5,280 ft per mi x 15 ft path width/ 43,560 square feet (sq ft) per ac) of McFaddin NWR land would be subject to vegetation damage as a result of equipment access, which equates to approximately 0.012% of the 58,355.59 ac of McFaddin NWR lands within the project area. The total potential impact area, 100 feet in width, is approximately 0.083% of McFaddin NWR lands within the project area.

The selection of lightweight drilling and support equipment best suited for each habitat type, the strategic location of source points, receivers, and access routes were designed to allow for avoidance of sensitive resources, and the fact that environmental monitors will be on site to ensure compliance with SUP conditions is expected to minimize rutting and confine impacts on vegetation to the herbaceous, shrub, and midstory layers within the operations area. Vegetation within the paths of the drills is likely to be crushed or killed, but would generally not be uprooted. The rootstock and plant material would remain in most impacted areas, allowing for quick recovery and the re-establishment of native vegetation.

The number of passes by equipment would be limited to the minimum necessary to accomplish objectives. Wherever possible, one drill (accompanied by support equipment) would travel only once down each source and access route. There would be instances where habitat limits the ability to travel from one source line to the next without traveling on the same path that was already used for access. In areas where this is the case, the drills and support equipment would

move over on the line (no less than 0.5 boat-width wide between each pass) so that they are not traveling in the exact same path that was traveled during previous access, if feasible. Rutting could occur along vehicle access routes, but all ruts would be restored as nearly as possible to pre-project conditions using shovels and rakes, minimizing the long-term impacts on soils, hydrology, and vegetation in the operations area.

Impacts would be minimal and temporary in nature, as both types of equipment are lightweight and vegetation would likely be cut, crushed and/or killed in the paths of the equipment; however, it would generally not be uprooted. Vegetation along the 2D line would likely recover within one to two growing seasons.

Helicopter drops of equipment could potentially result in impacts on vegetation, but are expected to limit the effect to vegetation overall, as it would minimize travel of support equipment through the area for equipment transport.

The deposition of drill cuttings could damage or kill vegetation immediately surrounding shothole locations and potentially affect the hydrology of the area, which could in turn affect vegetation. Impacts on vegetation surrounding the hole as a result of the deposition of drill cuttings are expected to be minimal, as the vegetation would remain rooted, and clay displaced from the hole would be distributed over the area such that the vegetation can emerge through it and re-establish.

The introduction and/or spread of non-native/invasive species also has the potential to adversely impact vegetation, as these species could out-compete native species and change the characteristics of the vegetation in localized areas. Areas accessed by equipment have the greatest potential for this to occur. In order to minimize the likelihood of introduction of non-native/invasive species, GXT will inspect and thoroughly wash all equipment prior to its use within the McFaddin NWR. Inspection and cleaning will be in approved locations as identified by the McFaddin NWR Manager.

Restoration of and/or mitigation for any unavoidable damages to vegetation would be required. Additionally, restoration of and mitigation for rutting and compaction of soils will be required, without which plant communities would likely be impacted. Restoration of vegetation damages will include re-vegetation and control of invasive/exotic plant species. Where direct restoration is not possible, required mitigation will include implementation of projects, which will preclude long-term hydrological alterations (especially increased saltwater intrusion) that could result from unavoidable soil and/or vegetation damages. Examples of restoration/mitigation projects that would prevent increased saltwater intrusion include hydrologic restoration projects to restore existing waterways to historic dimensions through construction of passive or active water control structures, restoring shorelines along existing waterways, and erosion-abatement projects along the GIWW and Gulf of Mexico shorelines.

Cumulative Effects

Cumulative adverse impacts on vegetation and habitat within the project area have occurred and will continue to occur because of natural processes, recreational activities, oil and gas operations, off-road vehicle use, and impacts on ozone sensitive species from air pollution. Marsh loss is the

most ominous problem faced by the Refuges. Marsh loss has occurred and will likely continue to occur as a result of natural events such as hurricanes, salt water intrusion, and invasion of exotic species, as well as conversion of habitat due to oil and gas operations and other actions. Impacts on vegetation have occurred due to the effects of past and present oil and gas exploration and production activities within the project area. Seismic activities have caused direct impacts to vegetation as a result of equipment travel across habitats, crushing plant biomass, and indirect impacts to vegetation as a result of compression of soils, potentially leading to saltwater intrusion. Saltwater intrusion stresses or kills plants and can further lead to erosion of soils through tidal exchange and eventually result in creation of open water habitat and thus a loss of vegetation within the project area. Exploratory drilling activities have caused direct impacts to vegetation through board road construction and drill pad construction and indirect impacts to vegetation through soil compression that potentially leads to changes in plant communities due to changes in elevation. Production activities have caused direct impacts to vegetation through well pad construction and indirect impacts to vegetation through inadvertent leaks from the well to surrounding habitat that leads to contamination of soils and mortality of plants.

With incorporation of the restrictions described in **Section 2.2.7 Mitigation Measures**, the proposed action's potential to contribute to cumulative impacts will be minimized. Beneficial cumulative effects to vegetation are expected to result from the USFWS' management of the McFaddin NWR, as the activities conducted in these areas would be subject to SUP stipulations designed to minimize impacts on vegetation.

Because GXT's proposed operations would be conducted under a SUP, with attached stipulations that would reduce impacts to vegetation and restore impacted sites to pre-existing project conditions upon cessation of activities, the operation's contribution towards cumulative effects on vegetation, when combined with other past, present, and future actions, is expected to be low to non-existent.

4.3.4 Fish and Wildlife

The proposed operation incorporates measures that would prevent or minimize effects to fish and wildlife populations and their habitats from most impacts. Noise impacts are expected to produce the greatest effect on wildlife populations because of their relatively high intensity level and large area of effect. As mentioned in **Section 4.2.4**, noise from drilling equipment, support vehicles, helicopters, detonation of charges, and the presence of crews could temporarily displace wildlife into adjacent habitat and/or temporarily alter the normal behavior of certain species. However, operations in any given area would occur intermittently for only a brief period before moving on. Additionally, GXT would conduct operations between April 15 and October 15, avoiding periods of highest migratory bird use (fall and spring migrations and wintering periods) to help minimize impacts. Peak concentrations of migrating and wintering waterfowl, shorebirds, wading birds and other wetland-dependent migratory birds on the McFaddin NWR occurs during spring and fall migrations and through winter. The operational timeframe also avoids most of the peak nesting period for mottled ducks and alligators by those seismic operations with the greatest potential for disturbance impacts (i.e., the drilling, laying of receiver equipment, and recording phases of the seismic operations).

Suitable adjacent habitat would be widely available for displaced wildlife to utilize during operations, and impacts on habitat values are expected to be short term. The majority of species would likely return to areas of operation as soon as crews and equipment have vacated these areas. Therefore, while fish and wildlife could be displaced and experience increased stress, decreased production and possibly mortality during the proposed operation, this effect is expected to be negligible to minimal.

The Proposed Action could potentially impact mottled ducks, alligators, nesting waterbirds, and colonial nesting waterbirds (terns) within the project area, as operations would be conducted within the nesting seasons of several species. In order to minimize the likelihood of this occurrence, GXT would offset operations a minimum distance of 1,000 ft from any active colonial waterbird rookery for protection of nesting birds, unless a variance is granted by USFWS McFaddin NWR Manager. Environmental monitors would be present to identify the locations of mottled ducks, alligators and waterbirds and their nests and activities would avoid these areas to the greatest extent practicable. Should seismic activities encroach closer than 1,000 ft from any colonial waterbird rookery, a monitor would be on site to assist in minimizing disturbance impacts. **Appendix B** provides an overview of actions for the identification and protection of colonial waterbird nesting areas.

Under this alternative, crews would not interact with fish or wildlife in the operations area. There would be no hunting or fishing allowed, and the harassment or destruction of wildlife would be prohibited. Similarly, the nests or dens of wildlife would not be damaged or destroyed, and areas containing nests or dens would be avoided. GXT will avoid sensitive habitat to the extent possible when laying out shot and receiver locations and conducting operations along the 2D line.

All cans, bottles, paper and other trash would be removed from McFaddin NWR lands daily to reduce the potential for wildlife attraction. All equipment would be washed before entering the operations area to help prevent the influx of exotic species. Additionally all equipment would be inspected for oil leaks, worn hydraulic hoses, and other potential hazards to the habitat, prior to entering the McFaddin NWR.

GXT would also have a trained environmental monitor(s) on site at all times during operations to serve as a daily liaison with McFaddin NWR staff, ensure provisions and stipulations of the SUP are adhered to, and to provide timely onsite guidance to seismic survey personnel. This will likely increase avoidance of disturbance impacts to migratory birds and other wildlife.

Under the Proposed Action, impacts to fish and wildlife would be less than those predicted for the No Action Alternative. USFWS management of the operations would, through the issuance of the SUP and monitoring, ensure strict compliance to its provisions and numerous stipulations designed to protect fish and wildlife.

Cumulative Effects

Cumulative impacts on fish and wildlife resources within the project area have occurred and would continue to occur as a result of oil and gas operations, man-made actions, hunting, recreational activities, on and off-road vehicle use, natural processes, and other sources of

disturbance or loss/modification of suitable wildlife habitat. Impacts on wildlife resources have occurred due to the effects of past and present oil and gas exploration and production activities within the project area. Seismic activities have caused disturbance impacts to wildlife resources through widespread equipment travel across habitats, causing temporary displacement of wildlife, and potential indirect impacts to wildlife resources as a result of compression of soils, potentially leading to saltwater intrusion. Saltwater intrusion stresses or kills plants and can further lead to erosion of soils through tidal exchange and eventually result in creation of open water habitat and thus a loss of vegetation within the project area. Loss of vegetated habitat can affect wildlife resources. Exploratory drilling activities have caused localized impacts to wildlife resources through temporary loss of habitat resulting from board road and drill pad construction and associated disturbance. Production activities have caused direct and indirect impacts to wildlife resources through well pad construction, road construction, traffic disturbance and contamination of soils and water.

USFWS management of the Refuges is expected to maintain or improve habitat for fish and wildlife resources, contributing to beneficial cumulative impacts. With incorporation of the restrictions described in **Section 2.2.7 Mitigation Measures**, the proposed action's potential to contribute to cumulative impacts on fish and wildlife resources will be minimized. Because effects of GXT's proposed operations on fish and wildlife resources would be negligible to minimal, would only last for the duration of operations, and would be conducted under a SUP with attached stipulations that would reduce impacts to wildlife resources (i.e. timeframe for operations avoiding the late fall, winter, and early spring migration for migratory birds that utilize the Refuge Complex), the operation's contribution towards cumulative effects on wildlife resources, when combined with other past, present, and future actions, is expected to be low to non-existent.

4.3.5 Land Use

Under this Alternative, conflicts with NWR public use and other management programs including prescribed burning, invasive plant species control, controlled grazing, wildlife and vegetation surveys and monitoring, and scientific research would be managed, controlled, or restricted at times in areas of use as opposed to Alternative B.

4.4 EFFECTS FROM IMPLEMENTING ALTERNATIVE B (NO ACTION ALTERNATIVE)

4.4.1 Geology and Soils

Under this Alternative, it is anticipated that impacts to soils and subsequent hydrological impacts would be greater than the Proposed Action (Alternative A) as a consequence of the lack of specific guidance on measures to minimize impacts to soils.

Overall damage to soils would be increased. Refuge management would not be consulted and would have no input into how activities would be conducted in sensitive habitats. Similarly, environmental monitors would not be on hand to assist survey and drilling teams with least impact equipment choices and access routes appropriate for the protection of habitat. Access

would not be restricted to the minimum number of passes necessary to accomplish objectives, and equipment operators would not be required to offset travel paths to minimize compaction and/or rutting. This would result in additional impacts to soils and vegetation. Impacted acreage would likely be three to four times that estimated for the Proposed Action and the intensity of the impacts would be greater. In addition to crushing and killing of vegetation along access routes, the probability of uprooting vegetation and compaction of soils increases with each pass of equipment.

There would be no requirement to use lightweight equipment and no requirement to re-contour/restore impacted areas under the No Action alternative. If trenching or rutting occurs in the marsh due to the use of heavy equipment, and the areas are not restored as nearly as possible to pre-project conditions, it could result in more severe impacts such as hydrologic modification, salt water intrusion, accelerated erosion, and/or a change in species composition and habitat type/characteristics.

Under this alternative, helicopters may not be used for support. This could result in additional passes of equipment through sensitive habitat, further increasing impacts to soils. Damage to levees, ditch banks, and natural waterway banks may also occur without consultation and monitoring, which may increase the risk of erosion and/or salt water intrusion.

There would be no mitigation measures designed to minimize the possibility of leaks or spills in the area under the No Action alternative; therefore the likelihood of soil contamination would be greater than that of the proposed action.

It is likely that more pits would be dug for drilling in the absence of stipulations requiring that pumps and hoses be used to the extent possible to obtain water for drilling. Increased digging of pits would likely result in increased soil disturbances. Similarly, GXT may not take special precautions when crossing shorelines of waterways or ponds. Without special consideration, these areas would likely be subject to increased rutting and subsequent soil erosion.

GXT would not be required to restore soil surface elevations at shot holes and water pits. Leaving drilling and pit cuttings on the surface would likely result in increased soil disturbance and sedimentation of adjacent areas.

Overall, the No Action alternative would have greater impacts on soils than the Proposed Action.

Cumulative Effects

Cumulative impacts of the No Action alternative would be similar to those described under the Proposed Action; however, the potential for contributing to cumulative impacts on geology and soils is greater under the No Action alternative. Operations conducted under the No Action alternative, combined with past and future actions and natural processes that result in similar effects, could result in accelerated erosion/land loss, habitat conversion, and/or contamination of soils. Without incorporation of the restrictions described in **Section 2.2.7 Mitigation Measures**, the No Action Alternative's potential to contribute to cumulative impacts would increase.

4.4.2 Hydrology and Water Quality

Under this Alternative, it is anticipated that impacts to surface and groundwater quality would be greater than the Proposed Action (Alternative A) as a consequence of the lack of specific guidance on measures to minimize impacts to water resources, which would be stipulated in the SUP and strictly adhered to by GXT.

Refuge management would not be consulted and would have no input into how activities would be conducted in sensitive wetland and open water habitats. Similarly, environmental monitors would not be on hand to assist survey and drilling teams with least impact equipment choices and access routes appropriate for the protection of these areas.

There would be no requirement to use lightweight equipment and no requirement to re-contour/restore impacted areas under the No Action alternative. If trenching or rutting occurs in the marsh due to the use of heavy equipment, and the areas are not restored as nearly as possible to pre-project conditions, it could result in accelerated erosion, hydrologic modification, and salt water intrusion.

Under this alternative, helicopters may not be used for support. This could result in additional passes of equipment through sensitive habitat, further increasing impacts to hydrology and water quality. Damage to levees, ditch banks, and natural waterway banks may also occur without consultation and monitoring, which may increase the risk of erosion and/or salt water intrusion.

Laying out of the 2D line and subsequent conduct of operations without full consideration of opportunities to avoid sensitive aquatic features would likely increase impacts to surface water quality. For example, increased ingress/egress of airboats and mechanized equipment and increased drilling activity would occur in open water and/or wetland habitats, resulting in increased water turbidities in those areas and subsequent impacts to submerged aquatic vegetation.

There would be no mitigation measures designed to minimize the possibility of leaks or spills in the area under the No Action alternative; therefore the likelihood of surface or ground water contamination would be greater than that of the proposed action.

Lack of trained environmental monitors to serve as daily liaisons with McFaddin NWR staff, ensure provisions and stipulations of a SUP are adhered to, and to provide timely onsite guidance to seismic survey personnel would likely increase impacts to surface and ground water quality.

Overall, the No Action alternative would have greater impacts on hydrology and water quality than the Proposed Action.

Cumulative Effects

Cumulative impacts of the No Action alternative would be similar to those described under the Proposed Action; however, the potential for contributing to cumulative impacts on hydrology and water quality is greater under the No Action alternative. Without incorporation of the restrictions described in **Section 2.2.7 Mitigation Measures**, the No Action Alternative's

potential to contribute to cumulative impacts would increase. Operations conducted under the No Action alternative, combined with past and future actions and natural processes that result in similar effects, could result in hydrologic modification, accelerated erosion/land loss, habitat conversion, and/or contamination of water.

4.4.3 Vegetation and Habitat

Under this Alternative, it is anticipated that impacts to habitats and vegetation would be greater than the Proposed Action (Alternative A) as a consequence of the lack of specific guidance on measures to minimize impacts to vegetation and habitat, which would be stipulated in the SUP and strictly adhered to by GXT.

Under the No Action alternative, impacts to vegetation and habitat would be greater than those associated with the Proposed Action, as there would be no SUP governing operations. Overall damage to vegetation and aquatic habitats would be increased. Refuge management would not be consulted and would have no input into how activities would be conducted in sensitive vegetative habitats. Similarly, environmental monitors would not be on hand to assist survey and drilling teams with least impact equipment choices and access routes appropriate for the protection of habitat. Access would not be restricted to a minimum number of passes necessary to accomplish objectives, and equipment operators would not be required to offset travel paths to minimize compaction and/or rutting or to avoid sensitive habitats. This would result in additional impacts to vegetation. Impacted acreage would likely be three to four times that estimated for the Proposed Action and the intensity of the impacts would be greater. In addition to crushing and killing of vegetation along access routes, the probability of uprooting vegetation increases with each pass of equipment.

There would be no requirement to use lightweight equipment and no requirement to re-contour/restore impacted areas under the No Action alternative. Increased use of terra-tired drilling and water rigs in wetland and transitional upland habitats would likely increase impacts to vegetation along the 2D line. Similarly, increased instances of repeated passes over the same areas, cross-country travel by mechanized equipment, and increased use of mechanized equipment to distribute and retrieve receiving equipment would likely result in increased mortality of plants along the 2D line, and increased soil compaction affecting larger areas, which could increase the potential for altering hydrological conditions and subsequently impact vegetation.

If trenching or rutting occurs in the marsh due to the use of heavy equipment, and the areas are not restored as nearly as possible to pre-project conditions, it could result in hydrologic modification, salt water intrusion, accelerated erosion, and/or a change in species composition and habitat type/characteristics.

There would be no cutting restrictions in place limiting the size and/or type of vegetation that can be cut or damaged as a result of operations. This could result in removal of larger canopy trees in forested areas (if present), increasing the potential for invasion by exotic species, including Chinese tallow. Additionally, impacting larger trees increases the time necessary for recovery of impacted areas.

There could be an increased number of pits dug to obtain water at the drilling sites rather than utilizing pumps and hose layouts to obtain water for drilling, and GXT would not be required to restore contours at pit locations. This would likely result in increased soil disturbances, increased potential for invasion from undesirable invasive plant species, and increased plant mortality at the shot hole locations.

Under this alternative, helicopters may not be used for support. This could result in additional passes of equipment through sensitive habitat, further increasing impacts to vegetation. Damage to levees, ditch banks, and natural waterway banks may also occur without consultation and monitoring, which may increase the risk of erosion and salt water intrusion, leading to a loss of vegetation and/or change in species composition.

The crews would not be required to wash equipment prior to use in the Refuge under this alternative, increasing the risk of introduction of invasive/exotic plant species.

Overall, the No Action alternative would have greater impacts on vegetation and habitat than the Proposed Action.

Cumulative Effects

Cumulative impacts of the No Action alternative would be similar to those described under the Proposed Action; however, the potential for contributing to cumulative impacts on vegetation and habitat resources is greater under the No Action alternative. Without incorporation of the restrictions described in **Section 2.2.7 Mitigation Measures**, the No Action Alternative's potential to contribute to cumulative impacts would increase. Operations conducted under the No Action alternative, combined with past and future actions and natural processes that result in similar effects, could result in hydrologic modification, accelerated erosion/land loss, habitat conversion, and/or contamination of soils and water.

4.4.4 Fish and Wildlife

Under the No Action alternative, operations would still occur; however, they would not be conducted under the guidelines of a SUP. Under this Alternative, impacts to fish and wildlife would be greater than the Proposed Action.

Without a SUP, project activities could occur outside of the seasonal timeframes specified by the USFWS, potentially during periods of highest migratory bird use (fall and spring migrations and wintering periods). Conducting operations during migrational or wintering periods would result in greater overall disturbance to migratory waterfowl, shorebirds, wading birds, and other wetland-dependent migratory birds than operations conducted between the April 15 to October 15 seasonal timeframe specified by the USFWS. Additionally, operations may not be offset away from rookery locations, causing disturbance to nesting species.

Under this alternative, there would be no stipulations restricting hunting, fishing, harassment or destruction of wildlife, destruction of nests or dens, avoidance of sensitive habitat or other

protections offered through a SUP. This being the case, there is a greater likelihood that wildlife could be killed, wounded, disturbed, or displaced.

There would be no environmental monitor(s) on site to serve as a daily liaison with McFaddin NWR staff, ensure provisions and stipulations of the SUP are adhered to, and to provide timely onsite guidance to seismic survey personnel; therefore, overall impacts to wildlife and wildlife habitat would likely increase.

Overall, the No Action alternative would have greater impacts on fish and wildlife than the Proposed Action.

Cumulative Effects

Cumulative impacts of the No Action alternative would be similar to those described under the Proposed Action; however, the potential for contributing to cumulative impacts on wildlife resources is greater under the No Action alternative due to the fact that operations would have greater impacts on habitat for aquatic and terrestrial species. Without incorporation of the restrictions described in **Section 2.2.7 Mitigation Measures**, the No Action Alternative's potential to contribute to cumulative impacts would increase. Operations conducted under the No Action alternative could potentially result in hydrologic modification, accelerated erosion, habitat conversion, contamination of soils and water, and other factors that could affect fish and wildlife populations in the project area. Combined with past and future actions and natural processes that result in similar effects, the No Action alternative could contribute to negative effects on fish and wildlife resources over the long-term.

4.4.5 Land Use

Under this Alternative, it is expected that increased conflicts with McFaddin NWR public use and management programs including prescribed burning, invasive plant species control, controlled grazing, wildlife and vegetation surveys and monitoring, and scientific research would occur as a consequence of the lack of specific guidance on mitigation measures to minimize these conflicts that would otherwise be stipulated in the SUP.

Cumulative Effects

Cumulative impacts of the No Action alternative on public use would be similar to those described under the Proposed Action; however, the potential for conversion and/or loss of habitat available for public use and socioeconomics is greater under the No Action alternative. Additionally, operations conducted under the No Action alternative could negatively affect fish and wildlife populations in the project area and result in a decrease in the amount of visitors who utilize the project area for hunting, wildlife viewing, fishing, etc. Without incorporation of the restrictions described in **Section 2.2.7 Mitigation Measures**, the No Action Alternative's potential to contribute to cumulative impacts would increase. Combined with past and future actions and natural processes that result in similar effects, the No Action alternative could contribute to negative effects on public use over the long-term.

5.0 REGULATORY FRAMEWORK

5.1 COASTAL MANAGEMENT ZONE

The Texas Coastal Management Program (TCMP), administered by the Texas Coastal Coordination Council (TCCC) through the Texas General Land Office, was created in response to the federal Coastal Zone Management Act, which affords protection to the nation's coastal resources. The Final Environmental Impact Statement (FEIS) for the TCMP was released in August 1996. The federal consistency requirement of the TCMP for the project will be met through the USACE Section 404/Section 10 Nationwide Permit 6 process.

5.2 FLOODPLAIN MANAGEMENT

Executive Order (EO) 11988, Floodplain Management - The project is situated in a floodplain. The activities associated with the proposed action must be located in the floodplains of McFaddin NWR to make the seismic survey feasible. The proposed action will not induce increased flooding in developed areas and will not contribute to increased future flood damage.

5.3 WATERS OF THE UNITED STATES

Executive Order (EO) 11990, Protection of Wetlands - The proposed action has been analyzed for compliance with EO 11990. Every attempt has been made to minimize impacts and preserve the value of wetland areas. No net loss of wetlands is anticipated as a result of GXT's proposed operations. Impacts are expected to be short-term, minimal, and localized to source and receiver locations. Any permanent impacts would be mitigated.

Clean Water Act Section 404/Rivers and Harbors Act Section 10; U.S. Army Corps of Engineers; "Waters of the United States", Including Wetlands; Nationwide Permit 6 - Section 404 and Section 10, through the USACE, afford protection of non-tidal and tidal waters of the United States, respectively. GXT has obtained authorization from the USACE to conduct proposed operations in wetland areas under a Nationwide Permit 6 with Preconstruction Notification (PCN). GXT will comply with the terms and conditions of the USACE permit.

5.4 ENDANGERED SPECIES

Endangered Species Act of 1973 – The Endangered Species Act, through USFWS, affords protection of the nation's listed threatened or endangered species. Interagency consultation procedures under Section 7 of the Act will be satisfied through the Clear Lake Ecological Services Field office of the USFWS.

5.5 ARCHAEOLOGICAL AND HISTORICAL RESOURCES

Section 106 of the National Historic Preservation Act affords protection to the nation's archaeological and historical (cultural) resources. The SHPO of the THC is responsible for overseeing Section 106 consistency within the State of Texas. GXT's cultural resource consultant completed a file search of known archaeological and historic resources within the

project area. This assessment was based on a search of the site files at the TARL. This file search revealed one site within or immediately adjacent to the project area. In addition, a cultural resource avoidance plan (**Appendix A**) describes low impact methodology, avoidance measures for known sites and high probability areas, and procedures to be followed in the event of inadvertent discovery. Federal consistency with Section 106 will be determined through the USACE permit and SUP processes.

5.6 WATER QUALITY

State water quality certification through Section 401 of the Clean Water Act will be obtained from the Railroad Commission of Texas through the USACE permit process. Additionally, GXT has submitted a request for a seismic letter of ground water protection from the Texas Commission on Environmental Quality, which will outline recommended groundwater protection measures. GXT will comply with recommendations provided in the letter.

5.7 STATE SUBMERGED LANDS

No submerged tracts of land, Permanent School Fund tracts and/or Relinquishment Act tracts owned by the State of Texas and administered by the Texas GLO are present within the project area.

5.8 ESSENTIAL FISH HABITAT

The USFWS has consulted with the NMFS on impacts to Essential Fish Habitat to satisfy the consultation procedures outlined in 50 CFR Section 600.290 of the regulation to implement the essential fish habitat provisions of the Magnuson-Stevens Fishery Conservation and Management Act.

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APPENDIX A
Cultural Resources Avoidance Plan

DESCO
DIXIE ENVIRONMENTAL SERVICES CO., LP
26902 Nichols Sawmill Rd, Magnolia, Texas 77355 • Phone: 281-252-9799 • Fax: 281-252-9767 • www.descoadvantage.com

May 2, 2012

Ms. Marie Archambeault
Texas Historical Commission
Archeology Division
El Rose Building
108 West 16th Street, 1st Floor
Austin, Texas 78701

RE: SWG-2012-00287
Gulf of Mexico LithoSpan Phase I 2D Seismic Survey
Draft Avoidance Plan for Archaeological Sensitive Areas

Dear Ms. Archambeault:

Enclosed please two (2) copies of the draft avoidance plan entitled "An Archaeological Sensitive Area Avoidance Plan for the Gulf of Mexico LithoSpan Phase I 2-D Seismic Project in Southeast Texas and the Gulf of Mexico" for your review. A copy of this plan has been sent to Mr. Jerry L. Androy at the US Army Corps of Engineers, Galveston District.

If you should have any questions regarding this report, please do not hesitate to contact Ms. Exa Grubb or me at your convenience. Both of us may be reached at (281) 252-9799.

Sincerely,

David M. Young
Senior Environmental Planner
Agent for GX Technology

CONCUR
by
for Mark Wolfe
State Historic Preservation Officer
Date 6/18/12
Track#

Enclosure

cc: DESCO
Mr. Jerry Androy, USACE Galveston District
Bruce Fulker, Cougar Land Services

AN ARCHAEOLOGICAL SENSITIVE AREA AVOIDANCE PLAN

FOR THE GULF OF MEXICO LITHOSPAN PHASE I 2-D SEISMIC PROJECT

IN SOUTHEAST TEXAS AND THE GULF OF MEXICO

(SWG-2012-00287)

Prepared for

Cougar Land Services, LLC
10701 Corporate Drive, Suite 377
Stafford, Texas 77477

Prepared by

Ed Baxter, RPA, Archaeological Consultant,
And
Exa M. Grubb, MSc, RPA, Senior Archaeologist

Dixie Environmental Services Company, LP
26902 Nichols Sawmill
Magnolia, Texas 77355

2012

ABSTRACT

GX Technology (GXT) has applied for a permit from the United States Army Corps of Engineers (USACE), Galveston District to conduct a 2-D seismic survey, referred to as the Gulf of Mexico (GOM) LithoSpan Phase I 2-D Seismic Survey. The proposed 2-D seismic survey line is approximately 411 miles (approximately 661 kilometers) long situated in the Southeast Texas counties of Angelina, Hardin, Jefferson, Polk, and Tyler and in the Gulf of Mexico. A portion of the project area is located within the McFaddin National Wildlife Refuge. This avoidance plan presents the results of extensive archival research and conversations with other professionals to identify recorded archaeological sites and cemeteries within the project area. Seismic avoidance area buffers of 50 meters (164 feet) will be placed around all of the identified cultural resources and cemeteries. Areas of high probability for the occurrence of non-recorded archaeological sites were developed based on the archival research and topographic features. These features include (but are not limited to) shorelines of streams, rivers, and lakes where a high probability area buffer of at least 100 feet was drawn. Early maps and local histories were utilized to develop high probability areas for historic sites. These areas will be avoided by seismic activities unless a cultural resource survey is conducted. There have been twenty-three archaeological projects conducted within the boundaries of the GOM LithoSpan Phase I 2-D seismic survey corridor. Twelve were area projects, and eleven were linear. No nautical archaeological projects have been conducted within the project area.

There are two previously recorded archaeological sites in the project corridor. Site was reported by G. E. Arnold sometime in the 1940's. It was reportedly the location of an old Indian burial ground and had been previously excavated to determine if graves existed. He visited the site and examined the pits and found no evidence of burials or any artifacts. The site's eligibility for listing in the National Register of Historic Places is unknown. Site 41JF50 was reported in 1978 by John Clark, working for the Texas Department of Transportation. It is a very long, narrow site located along the shoreline and surf zone of the Gulf of Mexico. It dates to the Paleo-Indian and Archaic periods based on the reported Clovis and archaic projectile points. This site was regarded as eligible for the National Register of Historic Places. There are no shipwrecks reported in the project area.

The historic period is evidenced by three towns and communities, scattered structures shown on historic maps and three cemeteries numbers AG-C047, AG-C094, and AG-C095. The communities are Chester was established in 1883, Peach Tree Village, established in 1809, the largest and most prominent of the villages established by the Alabama Indians, and Pine Island, established in 1839 and relocated to its present location inside the project area in 1888.

ACKNOWLEDGMENTS

The authors are grateful to the following individuals for their assistance. Bruce Fulker was our contact with Cougar Land Services, LLC. The United States Army Corps of Engineers (USACE) Galveston District Regulatory Project Manager is Ms. Tosin Sekoni. Jonathan Jarvis, TexSite and Atlas Coordinator at the Texas Archeological Research Laboratory (TARL), provided shapefiles depicting previously recorded sites in the project area. Jerry L. Androy, archaeologist at the USACE, Galveston District who provided advice and the most recent guidelines for conducting archeological sensitive area avoidance plans and Amy Borgens, Texas State Nautical Archaeologist, who provided shapefiles for the nautical high probability areas.

CONTENTS

Figures

Tables

INTRODUCTION

GX Technology (GXT) has applied for a permit from the United States Army Corps of Engineers (USACE), Galveston District to conduct the Gulf Of Mexico (GOM) LithoSpan 2-D Seismic Survey. The proposed 2-D seismic survey line is approximately 411 miles (approximately 661 kilometers) long situated in the Southeast Texas counties of Angelina, Hardin, Jefferson, Polk, and Tyler and in the Gulf of Mexico (Figure 1). The terrestrial portion of the proposed seismic line is approximately 139 miles (approximately 224 kilometers) long while the portion in the Gulf of Mexico measures approximately 272 miles (approximately 438 kilometers). The proposed project will cross through approximately 4 miles of the McFaddin National Wildlife Refuge (MNWR) within Jefferson County, Texas. The proposed project stops and recommences around three units of the Big Thicket National Preserve (BTNP) (Little Pine Island Bayou Corridor Unit, Lance Rosier Unit, and Hickory Creek Savannah Unit). The project area falls within twenty-three 7.5' USGS topographic quadrangles (Table 1).

In an effort to minimize impacts to cultural resources in the project area, GXT has hired Cougar Land Services, LLC (Cougar) to perform land management services, which includes obtaining environmental clearance from the USACE. Cougar has contracted with Dixie Environmental Services Co., LP (DESCO) to obtain environmental clearances and secure regulatory permits for the project. DESCO is developing an Archaeological Sensitive Area Avoidance Plan in accordance with the methodology and restrictions approved by the USACE and Texas Historical Commission (THC) in similar DESCO Avoidance Plans. This includes allowing DESCO to perform a records check for any cultural resources in the project area and an assessment of the project area for the high potential of undiscovered cultural resources that might be affected by seismic activities (High Probability Areas, or HPA). A half mile wide corridor (one forth mile either side of the seismic centerline) was established on the terrestrial portion of the project area to provide the seismic operatives the necessary space to avoid any sensitive areas. This corridor encompassed an area of 68 square miles (176 square kilometers), (435 acres), (17623 hectares). In order for a 2-D seismic survey to ensure that all cultural resources are protected during their seismic operations, special conditions accepted by the THC and USACE, Galveston District must be followed. The boundary of identified archaeological sites and cemeteries must be given a 50 meter (164-foot) avoidance buffer, in which seismic operatives may only place seismic receivers (geophones) using non-mechanical clearing of vegetation and walk-only procedures. Any intended drilling locations within the high probability areas must be assessed by an archaeologist in the field. That source point location may only be drilled after the archaeologist has notified the seismic operatives that the location is cleared for drilling. Previous archaeological projects, cemetery buffers, archaeological site buffers and the High Probability Areas are depicted on a map of the project area (Appendix I).

The proposed survey involves the collection of seismic data via an established receiver grid that will record the reflected seismic waves of small explosive charges at set intervals across the project area. This project will require a Nationwide 6 permit issued by the USACE and, therefore, falls under the regulation of 33 CFR Part 325, Appendix C (Processing Department of Army Permits: Procedures for the Protection of Historic Properties; Final Rule 1990; with current Interim Guidance Document dated April 25, 2005). In an effort to minimize

impacts to cultural resources in the project area, Cougar Land Services, LLC has requested that DESCO develop a Sensitive Area Avoidance Plan for submittal and approval to the USACE and the Texas State Historic Preservation Officer (SHPO) prior to the commencement of the proposed seismic survey.

This survey is tentatively scheduled to begin in July of 2012 and will take approximately 6 months to complete. The purpose of this seismic survey is to provide a high-resolution image of the subsurface geological features that will allow the client to effectively evaluate the hydrocarbon reserves underlying the project area. The client is working with the United States Fish and Wildlife Service to obtain a Special Use Permit for operations within the McFaddin National Wildlife Refuge. The low impact seismic methods follow the report as Appendix II.

There are twenty-nine bodies of water within the boundaries of the project area. They include bayous, branches, creeks, marshes, a river, and the Gulf of Mexico. No source points will be located in any of the sources of water mentioned above with the exception of the Gulf of Mexico where air guns will be utilized as the energy source and the marshes where the energy source will be explosive charges (e.g. *Pentolite*). Drilling will be accomplished by airboats in open water or shallow/marsh areas that are inundated; and tracked, lightweight marsh buggies in dry marshes.

This avoidance plan was prepared following the most recent guidelines entitled *Archeological Sensitive Area Avoidance Plan & Low-No Impact Methodology, Recommended Organization* compiled by the USACE and THC. These guidelines were obtained from USACE archaeologist Jerry L. Androy who is the reviewer for this project. These guidelines replace all previous versions.

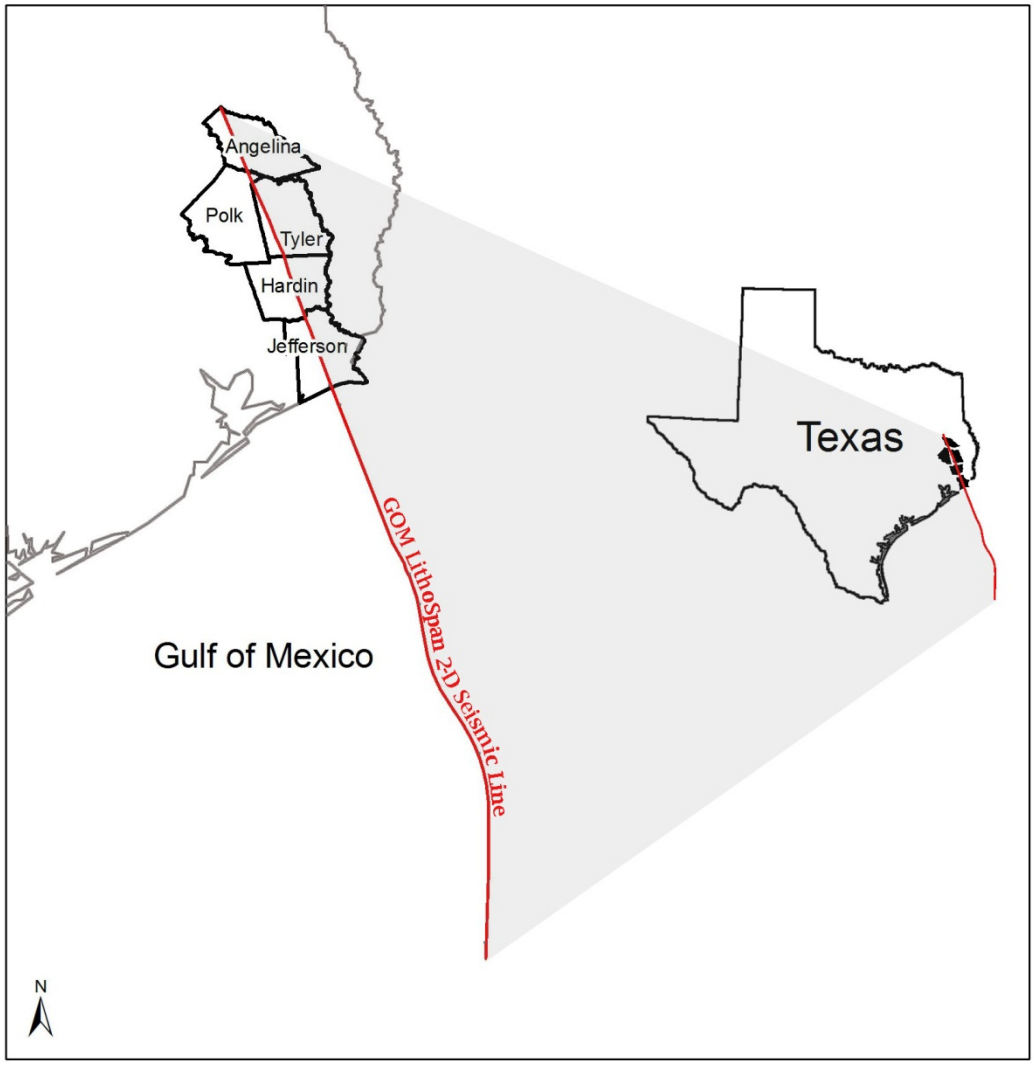

Figure 1. General Location

GOM LITHOSPAN 2-D USGS QUADRANGLES			
GNIS NAME	**USGS NUMBER**	**TNRIS NUMBER**	**STATE PLANE**
Alligator Hole Marsh	29094-G2	2994-442	South Central
Bald Hill	31094-B6	3194-213	Central
Beaumont West	30094-A2	3094-112	South Central
Bevil Oaks	30094-B3	3094-124	Central
Keltys	31094-C7	3194-231	Central
Camden	30094-H6	3094-343	Central
Chambliss Hill	30094-G5	3094-341	Central
Chester	30094-H5	3094-344	Central
China	30094-A3	3094-121	South Central
Clam Lake	29094-F1	2994-414	South Central
Clawson	31094-D7	3194-234	Central
Diboll	31094-B7	3194-224	Central
Fannett East	29094-H2	2994-443	South Central
Hillister	30094-F4	3094-423	Central
Jacks Creek North	30094-F5	3094-314	Central
Kountze South	30094-C3	3094-131	Central
Kountze SW	30094-C4	3094-132	Central
Lake Nacogdoches South	31094-E7	3194-321	Central
Lufkin	31094-C6	3194-242	Central
Pluck	31094-A6	3194-212	Central
Star Lake	29094-F2	2994-413	South Central
Village Mills	30094-D4	3094-133	Central
Warren	30094-E4	3094-422	Central

Table 1. USGS Topographic Maps

RESEARCH METHODS

A review of the Texas Archeological Sites Atlas (Atlas) (http://atlas.thc.state.tx.us/) was performed to obtain data relating to previously recorded archaeological sites and surveys. Using the Atlas program, site forms for those known sites in the project area were reviewed. A shapefile of previous archaeological projects was downloaded from the THC's FTP directory (ftp://ftp.thc.state.tx.us/GIS/archeological_projects/) and included on an ArcView drawing. Information on the various archaeological was obtained from the Atlas abstracts, and published archaeological reports. Site data on file at TARL was provided by Jonathan Jarvis who provided TARL site shapefiles clipped to the boundaries of the project area. Copies of topographic quadrangles at TARL depicting original site locations were made in order to be able to draw the site boundaries on project maps and to check the accuracy of the Atlas. Information regarding the local history was obtained through published histories, journals, documents, and the Texas State Historical Associations' *Handbook of Texas Online* (http://www.tshaonline.org/handbook/online).

The Texas Historic Sites Atlas (http://atlas.thc.state.tx.us/) contains information on cemeteries and other historical areas. This site was utilized in the cemetery and historical research. The Newberry Library's Texas Atlas of Historical County Boundaries was accessed, http://publications.newberry.org/ahcbp/downloadfiles.html. It depicts and describes the chronology of the various governmental boundaries that encompass the project area. This data was then used in the Historical Chronology section.

Historic maps were downloaded from the Texas Natural Resources Information System (TNRIS) (ftp://ftp2.tnris.org/Imagery/THO/) website and used in the development of the historic portions of the high probability areas. Locations of cemeteries, communities, structures, and other historically related features were documented. The maps include various early topographic quadrangles prepared by the USACE, the United States Department of Agriculture, the United States Geological Survey, and the Tennessee Valley Authority (Table 3).

The results of this data gathering were then used to plot previously recorded archaeological sites and cemeteries on the Avoidance Map (Appendix I). Knowledge gained from previous archaeological surveys archaeological sensitive areas avoidance plans were utilized to predict the probability of undiscovered archaeological sites on the topographic features of the current project area.

ENVIRONMENTAL SETTING

The project area is located within the Austroriparian Biotic Province that extends along the Gulf Coast from the Atlantic to the eastern portion of Texas. There are three distinct vegetation types within the province; these are (1) longleaf pine, (2) pine-oak (loblolly-shortleaf) and (3) coastal prairie. Vertebrate faunas within the Austroriparian include 47 species of mammals, 29+ species of snakes, 10 lizards, 2 land turtles, 17 anurans (frogs and toads) and 18 urodeles (salamanders). There are more species of amphibians recorded for this province than for any other province of Texas (Blair 1950).

The project area falls within the Outer Coastal Plain Mixed Forest Region of the United States. Three sections within the project area of this region are the Western Gulf Coastal Plains and Flatwoods, Louisiana Coastal Prairies and Marshes, and water. Subsections of the Western Gulf Coastal Plains and Flatwoods are the Piney Woods Transition, Southern Loam Hills, and Southwest Flatwoods. Subsections of the Louisiana Coastal Prairies and Marshes include the Louisiana-Texas Gulf Coast Marshes and Inland Bays, and the Gulf Coast Prairie. The subsection of Water is Water. The above was taken from The United States Department of Agriculture, Forest Service (2007). Specific detailed descriptions of each subsection can be found at http://www.fs.fed.us/land/pubs/ecoregions/ch21.html.

The area is drained by the Neches River Basin and water bodies in the project area include Big Cypress Creek, Black Creek, Caney Creek, coastal marsh, Crawford Creek, Cypress Creek, Din Bayou, Georges Creek, Hickory Creek, Horsepen Creek, Hurricane Creek, Jones Branch, Little Pine Island Bayou, Moccasin Creek, Neches River, Pine Island Bayou, Piney Creek, Prairie Creek, Stovall Creek, Taylor Bayou, Village Creek, Vincent Creek, Walker Branch, Willow Slough Marsh, Zed Creek, and the Gulf of Mexico.

East Texas is within the humid subtropical climate zone. It receives the most rainfall of Texas; more than 60 inches (1,500 mm) annually in the far east. This is due to the gulf currents that carry humid air to the region, where it condenses and precipitates out in the vicinity of sea breeze fronts. While coastal sections see the cloudiest days statewide and year-round, northern sections see the clearest days during the summer. The wettest months of the year are April and May. The area is prone to severe thunderstorms and tornadoes when the proper conditions exist, generally in the springtime. Hurricanes also strike the region. The higher humidity of the region amplifies the feeling of heat during the summer. During winter and spring along the immediate coast, temperatures are kept cool by relatively cool gulf waters. Dense fog can form when warm air moves over the cool shelf waters during February and March.

The geologic time periods represented in the surface and near surface geology of the area include the Eocene, Holocene, Miocene, Oligocene, Pleistocene, and Quaternary. Table 2 below illustrates the Unit Age, Rock Type, Acres and Square Miles of the surface and near surface geology of the seismic corridor taken from data found at the USGS website (http://tin.er.usgs.gov/geology/state/state.php?state=TX).

GEOLOGY OF THE GOM 2-D SEISMIC CORRIDOR					
LABEL	**UNIT AGE**	**ROCK TYPE 1**	**ROCK TYPE 2**	**ACRES**	**SQUARE MILES**
Eca	Eocene	siltstone	clay or mud	1668.59	2.61
Ecm	Eocene	clay or mud	sandstone	1277.86	2
Em	Eocene	clay or mud	sand	23.52	0.04
Es	Eocene	sand	clay or mud	404.17	0.63
Ewb	Eocene	sandstone	sand	80.95	0.13
Ey	Middle Eocene	clay or mud	sandstone	4489.95	7.02
Mf	Miocene	clay or mud	sandstone	4297.85	6.72
Oc	Oligocene	mudstone	sand	632.23	0.99
OEw	Oligocene and Eocene	clay or mud	sandstone	537.54	0.84
Pow	Pliocene	clay or mud	silt	3864.46	6.04
Qal	Holocene	sand	silt	5933.13	9.27
Qbc	Quaternary; Late Pleistocene	clay or mud	silt	5939.78	9.28
Qbr	Quaternary; Holocene	sand	silt	164.75	0.26
Qbs	Quaternary; Late Pleistocene	sand	silt	5767.99	9.01
Ql	Quaternary; Middle Pleistocene	sand	silt	7174.95	11.21
Qt	Pleistocene and Holocene	terrace	sand	1264.15	1.98

Table 2. GOM LithoSpan 2-D Line Corridor Geology

MAP TITLE	SCALE	DATE	ORIGINAL AGENCY	PUBLISHER
Alligator Hole Marsh Quadrangle	1:24,000	1962	U. S. Geological Survey	U. S. Dept. of the Interior, U.S.G.S.
Bald Hill Quadrangle	1:24,000	1962	U. S. Geological Survey	U. S. Dept. of the Interior, U.S.G.S.
Beaumont West Quadrangle	1:31,680	1943	Tennessee Valley Authority	U.S. Army Corps of Engineers
Beaumont West Quadrangle	1:24,000	1959	U. S. Geological Survey	U. S. Dept. of Interior, U.S.G.S.
Big Hill Quadrangle	1:31,680	1943	Tennessee Valley Authority	U.S. Army Corps of Engineers
Camden Quadrangle	1:62,500	1952	U. S. Geological Survey	U. S. Dept. of Interior, U.S.G.S.
Clam Lake Quadrangle	1:31,680	1943	Tennessee Valley Authority	U.S. Army Corps of Engineers
Clam Lake Quadrangle	1:24,000	1961	U. S. Geological Survey	U. S. Dept. of the Interior, U.S.G.S.
Clawson Quadrangle	1:24,000	1947	U. S. Geological Survey	U. S. Dept. of the Interior, U.S.G.S.
Colmesneil Quadrangle	1:125,000	1940	U. S. Army Corps of Engineers	U. S. Dept. of the Interior, U.S.G.S.
Douglass Quadrangle	1:62,500	1947	U. S. Geological Survey	U. S. Dept. of the Interior, U.S.G.S.
Fannett East Quadrangle	1:24,000	1942	U. S. Geological Survey	U. S. Dept. of the Interior, U.S.G.S.
Fannett East Quadrangle	1:31,680	1943	Tennessee Valley Authority	U.S. Army Corps of Engineers
Fannett East Quadrangle	1:24,000	1960	U. S. Geological Survey	U. S. Dept. of the Interior, U.S.G.S.
Soil Map Jefferson County Texas	1:63,300	1913	U. S. Department of Agriculture	None Listed
Keltys Quadrangle	1:24,000	1947	U. S. Geological Survey	U. S. Dept. of the Interior, U.S.G.S.
Kountz Quadrangle	1:62,500	1952	U. S. Geological Survey	U. S. Dept. of the Interior, U.S.G.S.
Soil Map Lufkin Texas	1:63,305	1903	U. S. Department of Agriculture	A. Hoen & Co. Lith. Baltimore, Md.
Lufkin Quadrangle	1:62,500	1956	U. S. Geological Survey	U. S. Dept. of the Interior, U.S.G.S.
Lufkin Quadrangle	1:24,000	1946	U. S. Geological Survey	U. S. Dept. of the Interior, U.S.G.S.
Manning Quadrangle	1:62,500	1928	U. S. Geological Survey	U. S. Dept. of the Interior, U.S.G.S.
Map of the State of Texas	1:639,839	1867	None Listed	None Listed
Soil Map Nacogdoches County Texas	1:63,301	1925	U. S. Department of Agriculture	None Listed
Pluck Quadrangle	1:2,4000	1962	U. S. Geological Survey	U. S. Dept. of the Interior, U.S.G.S.

Table 3. Historical Maps

MAP TITLE	SCALE	DATE	ORIGINAL AGENCY	PUBLISHER
Soil Map of Polk County Texas	1:63,297	1930	U. S. Department of Agriculture	Litho Eastern Offset Inc., Baltimore, Md.
Railroad Map of the State of Texas	1:2,246,751	1873	None Listed	None Listed
Segno Quadrangle	1:62,500	1952	U. S. Geological Survey	U. S. Dept. of the Interior, U.S.G.S.
Sour Lake Quadrangle	1:62,500	1952	U. S. Geological Survey	U. S. Dept. of the Interior, U.S.G.S.
Star Lake Quadrangle	1:31,680	1943	Tennessee Valley Authority	U.S. Army Corps of Engineers
Star Lake Quadrangle	1:24,000	1960	U. S. Geological Survey	U. S. Dept. of the Interior, U.S.G.S.
Warren Quadrangle	1:62,500	1952	U. S. Geological Survey	U. S. Dept. of the Interior, U.S.G.S.
Warren Quadrangle	1:62,500	1952	U. S. Geological Survey	U. S. Dept. of the Interior, U.S.G.S.

Table 3. Historical Maps continued

PREHISTORIC CHRONOLOGY

The project area is located in both the Northeast and Southeast archaeological regions as defined by the THC (Figure 2*)*. The THC commissioned and published an archaeological bibliography for the Northeastern Region of Texas compiled by William A. Martin (1990) and the Southeastern Region that was compiled by William E. Moore (1989). Detailed summaries of Northeast and Southeast Texas prehistory can be found in the works by Lawrence E. Aten (1983a, 1983b), Dee Ann Story, et al. (1954, 1990), and Timothy K. Perttula (1992, 1995, 1996, 1998, 2004). Texas prehistory can be divided into four general temporal periods: Paleo-Indian, Archaic, Early Ceramic (or Woodland), and Late Prehistoric, which includes the emergence and development of the Caddoan culture.

Paleo-Indian Period

The Paleo-Indian period is the time following the Pleistocene Ice Age in North America when early prehistoric Americans pursued megafauna such as mammoth, mastodon, and a now-extinct species of bison. Story et al. (1990) has suggested that plants and other smaller animals probably were as important to the Paleo-Indians as the large animals. Owens (2009) thinks that there is little evidence in the southeast Texas region for hunting of extinct megafauna, as has been documented elsewhere in North America; rather, he states that a broad-based subsistence pattern appears to have been practiced during all prehistoric time periods. The Paleo-Indians' lithic technology was superb as demonstrated the projectile points of this era. Patterson (1995) divides the Paleo-Indian period in East Texas into early and late components based on the projectile points. He sees the Early Paleo-Indian period lasting from 10,000 B.C. to 8,000 B.C. as represented by *Clovis*, *Folsom, Dalton, San Patrice,* and *Big Sandy* fluted projectile points. The Late Paleo-Indian period is seen as lasting from 8,000 B.C. to 5000 B.C. as represented by *Plainview, Scottsbluff, Meserve,* and *Angostura* un-fluted lanceolate points. In the east Texas area, early man points are typically found on the surface. The best known site of this period in Southeast Texas is the McFaddin Beach Site, (41JF50) which is in the project area. At this site numerous Paleo-Indian artifacts have been collected from the beach causing archaeologists to speculate that the actual site is under the waters of the Gulf of Mexico and was inhabited during the ice age when sea levels were lower. Dates for the time span of this period vary; Ensor (1991:8) believes it lasted circa 10,000 B.C. to 8,000 B.C. while Patterson (1995) thinks that in Southeast Texas it was from circa 10,000 B.C. to 5000 B.C. based on his projectile point typology analysis.

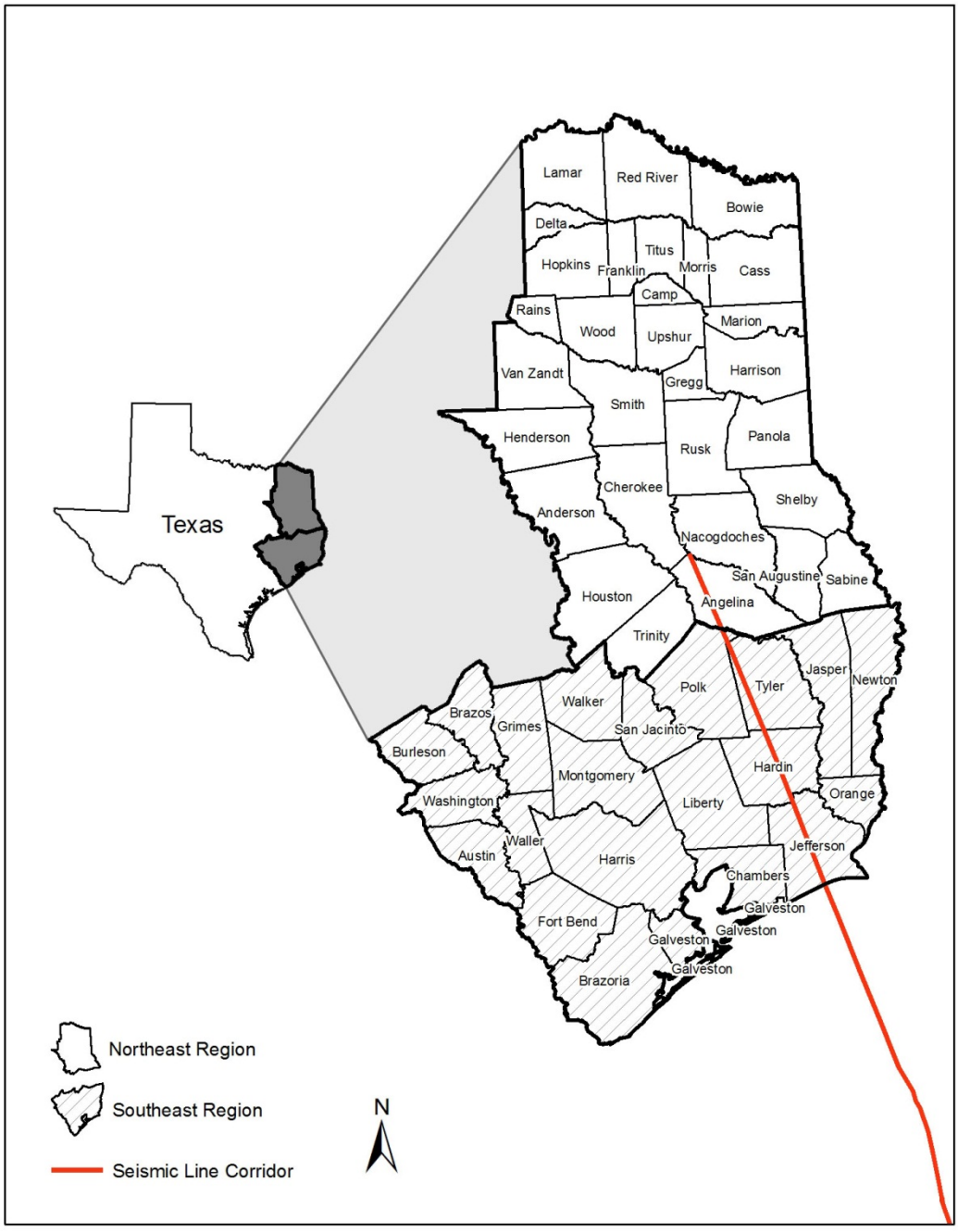

Figure 2. Northeast and Southeast Regions of Texas

Archaic Period

The Archaic Period follows the Paleo-Indian Period and is thought to have marked the time of the extinction of Pleistocene megafauna. During this time small bands of hunters and gatherers roamed the countryside in search of plants and small animals. The greater number of sites from this period indicates a greater population. The period is divided into the Early, Middle, and Late periods based on characteristic types of artifacts, especially projectile points. Ricklis (2004) has presented a chronology of dart points for this period in East Texas. These tool assemblages suggest differences in economy, technology, and possibly regional adaptations (Feit et al. 2008). Dippel (2001:4-2) states that the Archaic in East Texas lasted from 6000 B.C. to 200 B.C. Duffield (1963) views the Early Archaic as a transitional period from Paleo-Indian to Archaic times, based on a marked change in technology rather than subsistence. Coleman et al. (1984) believe that these changes may have been the result of population increases that produced a greater emphasis on territoriality and a greater reliance on the inferior local lithic resources. Research by some archaeologists (Perttula and Skiles 1987; Story 1985; Perttula 1995) at Early Archaic sites indicates that these groups tended to be small, highly mobile, and widely scattered with recurrent occupations centered around terrace and upland projections within major river basins. According to Dippel (2001:4-2), the Middle Archaic is the first well-documented period in the region. According to her, "the distribution of these sites tends to indicate a settlement system based along the major basins and more limited use of smaller tributaries and headwater areas." Dippel states that subsistence strategies still depended on a hunting and gathering economy, but there was a greater reliance on native plants. She also states that the Late Archaic period is the best documented Archaic component in the Piney Woods of East Texas (2001:4-3). Late Archaic period sites outnumber those of the previous periods. The greater number of sites suggests that a significant population growth occurred during this time (Feit et al. 2008). Data from Late Archaic sites in Southeast Texas also indicate that people were becoming more sedentary. Late Archaic sites are more widely distributed throughout the region (Shafer 1975; Perttula 1995). Cemeteries came into being in the Archaic period as well (Story et al. 1990) and became an integral part of the late Archaic (Ricklis 2004). Only one Archaic period site has been reported in the project area, 41JF50

Early Ceramic

The Early Ceramic Period (circa 200 B.C. – circa A.D. 800) began about 2000 years ago when the ancestral Caddos began to settle and live in villages (Shafer 1975). Perttula (2004) calls this the Woodland Period. Ceramics and the bow and arrow were developed and larger villages and mound centers existed, especially along the major rivers. These people were still primarily hunters and gatherers who lived in increasingly larger groups and resided for longer periods of time at certain sites (Perttula 2004:377), there was a greater reliance on cultigens.

Late Prehistoric

The Late Prehistoric Period in East Texas is an indigenous development that was strongly influenced by the Mississippian tradition of the Lower Mississippi Valley (Story et al. 1990). Caddo subsistence and social organization differed markedly from the preceding Archaic

periods. The practices of horticulture and agriculture became the chief subsistence activity while hunting and gathering became secondary. This lifeway change created sedentary populations who inhabited villages. This permanency and a surplus of labor led to the development of public ceremonial areas, and the construction of ceremonial mounds that often were used as burial places. Service (1962, 1975) states that extensive commercial networks were established and a stratified social structure developed corresponding to the chiefdom level. Perttula (2004) divides the development of the Caddo culture into five separate development stages. These are the Woodland Period; the Formative Period; and the Early, Middle, and Late Caddo periods. The most common types of Caddoan settlement were hamlets and farmsteads, although larger communities were established in association with mound centers (Perttula 1995). Late Prehistoric tribes within the project area include the Adai, Atakapa, Caddo, and the Hasinai.

HISTORIC CHRONOLOGY

Exploration

The early exploration of Texas was due to the rivalry of France and Spain in their quest for new lands to exploit. Spain was at the height of her power after defeating the Moors but needed gold to fill the monarch's coffers (Bolton 1921:2).

Spain claimed the land that is now Texas in 1519, when the explorer Alonso Alvarez de Piñeda went looking for a waterway through the mainland to the Pacific Ocean. He sailed along the Gulf Coast from Florida to Vera Cruz (Bourne 1907:136).

In June of 1527 Pánfilo de Narváez sailed from Spain with six hundred colonists. One of his officers was Cabeza de Vaca. On November 6, 1528, while sailing along the coast, a storm separated the flotilla and Vaca's boat and two others were wrecked on Galveston Island (Bolton 1921: 25). This was probably the first European contact with Indians in the upper Texas coast. Vaca and three others lived with the Hans or Capoques. Aten (1983b) suggests that the Hans may have been related to the Akokisa, and that Capoques is another name for the Karankawa. Vaca was one of the four survivors, and wrote about his experiences with the Indians after he reached Mexico City.

The French explorer LaSalle sailed along the coast of Texas in 1685 during his attempt to find the mouth of the Mississippi River and to explore the western portion of New France. The expedition landed on the southwestern shore of Matagorda Bay. The hostile attitude of the native Americans left many of the colonists discouraged so they returned to France on one of the boats. One hundred and eighty persons were left on the bay and they established a rude fort named St. Louis which was later moved further up the river. They soon learned the river was not the Mississippi (Bancroft 1886:402). One of LaSalle's officers, Henri Joutel, kept a journal that is a major early source of information about the Indians in Southeast Texas. His writings were first published in *Joutel's Journal of La Salle's Last Voyage* in 1714 and reprinted by Texas State Historical Association under the title *The LaSalle Expedition to Texas: The Journal of Henri Joutel, 1684-1687* (Foster 1998). As a result of LaSalle's explorations and settlement the Spanish decided to establish missions to reaffirm their claims to the area for Spain.

Spanish Texas

The main Spanish influence in the area of the project location was the establishment of the Spanish missions of East Texas. The Spanish royal administration closely coordinated all missionary activity in the New World. In Texas only rarely did missionaries venture into hinterlands without official authorization and without soldiers being stationed at nearby presidios for protection. A total of 35 missions were established in Texas. Franciscans were given responsibility for all the Texas missions and the East Texas missions program was started in 1690. The missionaries traveled along El Camino Real that is currently the path of State Highway 21 in central and east Texas (Plocheck n.d.).

San Francisco de los Tejas was the first mission in East Texas. It was established in 1690 on San Pedro Creek (Weddle n.d.) The mission was Spain's response to the La Salle expedition. A few months after it was started, Santísima Nombre de María was established closer to the Neches River. In 1692, a flood destroyed Santísma Nombre de María and the friars returned to San Francisco de los Tejas, which, in turn, was abandoned in 1693 because of sickness and hostile Indians. Nuestro Padre San Francisco de los Tejas was re-established on the west bank of the Neches River in 1716 as the successor to the Mission San Francisco de los Tejas. In 1721, the mission was moved to the east bank of the river in what is now Cherokee County and renamed San Francisco de los Neches. In 1716, three other missions were founded in Nacogdoches County: Nuestra Señora de Guadalupe de los Nacogdoches, Nuestra Señora de la Purísima Concepción de los Hasinai and San José de los Nazonis. In San Augustine County in January 1717, the Franciscans founded Nuestra Señora de Dolores de los Ais (Long n.d.).

In 1719, French incursions from Louisiana caused all the East Texas missions to be temporarily vacated, but they were restored in 1721. While the three missions operated by the Querétero Franciscan college (San Francisco, Concepción, and San José) were removed to Austin in 1730 (see following), Missions Dolores and Guadalupe remained in East Texas until they were abandoned in 1773 (Chipman n.d.).

In 1756, the Mission Nuestra Senora de la Luz was established near the mouth of the Trinity River. It was destroyed by the Karankawa Indians and moved further north. In 1763 Spain acquired Louisiana and the French were no longer a threat. In 1771 the mission was abandoned (Chipman n.d.).

The area was home to the Caddos who occupied the hills to the north and the Atakapa who occupied the lands along the Gulf Coast and Trinity River bottoms. In the early 1800's Native American groups that had been pushed westward by Anglo expansion were in East Texas (Biesele, n.d.). These included the Alabama Indians, the Coushatta, and the Cherokee. The main town of the Alabama Indians, Peach Tree Village, is located within the project area.

Mexican Texas

The Republic of Mexico gained its independence from Spain in 1821. The present Texas became part of Mexico. Under the 1824 Constitution for the Republic of Mexico, the state of Coahuila and the former Spanish province of Texas were united and organized as the state of Coahuila and Texas; this included part of present east Texas and the northern part of Mexico.

In 1826 the original county of Nacogdoches was established as a municipality by Mexico. This included the entire project area. In 1829 there were two impresario grants awarded to David G. Burnet and Lorenzo de Zavala in the lands of the current project area. Burnet received a contract to settle 300 families and Zavala was authorized to settle 500 families. Neither were able to attract any colonists and both sold their grants to a group of investors of the Galveston Bay and Texas Land Company (Henson n.d.). However the Law of April 6, 1830 was imitated to stop the flood of immigration from the United States to Texas and encourage the colonists

from Mexico and Europe. This was done by forbidding the introduction of slaves into Mexico. This law provoked the Americans in Texas and led to the Texas Revolution (Bishop n.d.).

Republic of Texas

During the Republic of Texas era, 1836-1846, several changes occurred in East Texas. More settlers arrived and more communities arose due to the liberal land laws adopted in the Texas Constitution. The Mexican government sent agents to stir up trouble within the Mexican and Indian populations. Vicente Cordova organized a Mexican-Indian group around Nacogdoches resulting in a rebellion. He was repulsed by Major General Thomas J. Rusk, the local militia commander. In response Governor Lamar later drove the Cherokees out of Texas. Soldiers also forced the Shawnees, Alabamas, and Coushattas to abandon their hunting grounds; the last two tribes were given lands in East Texas. Speculators and settlers swarmed into vacated Indian land (Nance n.d.). During this time the Alabama Indians left Peach Tree Village and the current project area.

State of Texas

This era (1846 to Present) has seen the further settlement and development of East Texas to the present time. The five counties of the project area have been created in a secession of boundary changes. In 1826 Nacogdoches, the original county, was formed as a municipality of Mexico. This county encompassed 49,068 square miles and all of the present project area. Through time this county diminished in size due to the creation of other counties. The present day counties in the project area are Angelina, Hardin, Jefferson, Polk, and Tyler. Angelina County was created in 1846. Hardin County was created in 1858 from Jefferson, Liberty, and Tyler counties. Jefferson County became a Republic of Texas county in 1836. It later lost land to the following counties: Jasper in 1837, Galveston in 1840, Orange in 1852, Hardin in 1857, and to Chambers in 1858. Polk County was created from Liberty County in 1846. It lost land from the creation of San Jacinto County in 1870. It gained land from Trinity County in 1875. Tyler County was created from a portion of Liberty County in 1846 and lost lands due to the creation of Hardin County in 1858 (Long 2010).

The Civil War, 1861-1865, influenced the area. There were no battles in the project area but the population changed. Many of the fathers and sons went off to fight while others hid in the Big Thicket to avoid the conflict. The closest military engagements were the capture of Galveston by the Federals in October of 1862 and the Battle of Sabine Pass in September 1862 where the Confederate forces repulsed the Union forces (Wooster, Ralph n.d.).

The settlement and economic history of the five county area is much the same as that of the rest of East Texas. Prior to the 1880s, the population was scattered, mainly living on subsistence farms. They subsisted on gardening, plant collecting, hunting, and the free range hogs and cattle. In the 1880s, the lumber industry brought on by the establishment of railroads greatly changed the economy in the area. Virgin forests were cut thereby increasing the amount of land for farming and grazing.

In 1901, oil was discovered in East Texas and the resulting boom brought new energy and people into the area that was depressed by the declining timber industry.

World War II marked the next major change in the area. The sediment population was uprooted as many of the men entered the military and others left to work in the shipyards. The war's upheaval changed the people who did return. They were worldlier, less content to stay on the farm, and mobile due to the creation of paved roads, many of them built on the old lumber trams. About this time the expansion of the electrical grid and phone service into the rural areas brought about a much better communication system, the desire for more consumer goods, and the ability of people to commute to work in the towns while living in the country.

ARCHEOLOGICAL BACKGROUND

The Atlas reveals that there have been 722 recorded archaeological sites, 22 State Archaeological Landmarks, and 67 National Register of Historic Places properties in the project area counties as of April 11, 2012. Angelina County has 211 previously recorded archaeological sites, no State Archaeological Landmarks, and 41 National Register of Historic Places properties. Hardin County has 53 previously recorded sites, no State Archaeological Landmarks, and two National Register of Historic Places properties. Jefferson County has 97 previously recorded sites, 19 State Archaeological Landmarks, and 22 National Register of Historic Places properties. Polk County has 272 previously recorded sites, three State Archaeological Landmarks, and two National Register of Historic Places properties. Tyler County 89 has previously recorded sites, no State Archaeological Landmarks, and no National Register of Historic Places properties.

The majority of prehistoric sites are Archaic and Late Prehistoric in age. The most common features are hearths and fire pits. Burials are less common but are present at some sites. The historic sites include farms and outbuildings, shipwrecks, government buildings, churches, residences, and historic industrial sites related to the transportation, timber, and oil industries.

The majority of the State Archaeological Landmarks are shipwrecks that have no State of Texas Trinomial but a THC shipwreck inventory number.

The National Register of Historic Places properties range from courthouses, to early homes, to churches, and to early industrial sites such as oil wells.

Historic Indian villages in the counties belong to the Alabama, Coushatta and Taensa tribes (Kenmotsu and Perttula 1993:172). The one known Indian Village in the project area is Peach Tree Village, the main village of the Alabamas in Texas.

PREVIOUS ARCHEOLOGICAL INVESTIGATIONS

General

Most of the archaeological sites known to exist in the counties have been identified by surveys associated with early University of Texas researchers in the 1930s and early 1940s, reservoir construction and in-house projects by National Forest personnel.

Gus E. Arnold of The University of Texas traveled throughout East Texas in the 1940s and documented sites under the Works Progress Administration (WPA). His site locations were not always precise and many of his sites cannot be found today. TARL personnel, based on the best available information regarding the location of these sites, later assigned official state trinomials. Sites 41AG2 and 41AG21 were recorded by Arnold within or near the current project area. Andy Kyle, a local artifact collector, visited several sites in east Texas between 1946 and 1986. No formal report was made of his work but he took notes on his collections. Leland W. Patterson documented Kyle's collection of projectile points and published his findings in the *Journal of the Houston Archeological Society* (Patterson 1986).

From the late 1940s until the mid-1970s, most of the archaeological research in East Texas was carried out in connection with reservoir construction. In 1948 Robert L. Stephenson published the results of his work at the proposed McGee Bend Reservoir in Angelina, Jasper, Nacogdoches, Sabine, and San Augustine counties (Stephenson 1948). He also surveyed Dam "B" Reservoir (Stephenson 1949), now Steinhagen Lake in Jasper and Tyler counties. Other works include Steinhagen Lake (Perttula et al. 1998), Rockland Reservoir along the Neches River in Angelina, Polk, Tyler, and Trinity counties (never constructed) (Jelks 1954), and McGee Bend now Lake Sam Rayburn (Tunnell 1961 and Jelks 1965).

In 1974 and 1975, a study of the prehistoric resources in the Big Thicket National Preserve was conducted by Texas A&M University (TAMU) under the supervision of Harry J. Shafer (Shafer et al. 1975). Ed Baxter was the field archeologist. This survey visited parts of all units in the Big Thicket National Preserve. A second investigation by TAMU was a historical survey of all units within the Big Thicket National Preserve by researchers from the TAMU Research Foundation (Treat and Dethloff 1978).

In 1977, a survey was conducted by Texas A&M University for the Tennessee Gas Pipeline Company under the supervision of Harry J. Shafer and Ed Baxter. Robert A. Taylor was the project archaeologist. Site 41TL3 was recorded based on the presence of one flake of silicified wood and one cobble fragment found on the east bank of Little Cypress Creek. It was recommended that the terrace edge above the creek be intensively surveyed, including limited testing, to determine limits and significance of the site (Taylor 1979).

In 1979, Daniel E. Fox (1979), working for the Texas Department of Water Resources, recorded site 41TL23 while investigating a power line easement. He observed a disturbed scatter of ceramics and lithics exposed in the eroded ruts of a road. Fox recommended that the area to the north be examined for intact portions of the site.

In 1983, John Ippolito of the National Forest Service produced a cultural resource overview of the National Forests in Texas (Ippolito 1983). Of particular relevance to this project is Ippolito's Figure 21 entitled "Drainage Systems & Probability Zones, Angelina National Forest, Texas."

In 1985, Frank Weir (1985) of the Texas Department of Transportation surveyed a 6.2-mile area of United States highways 69, 96, and 287 from State Highway 105 north to the United States Highway 69-96 interchange in Jefferson and Hardin counties. No sites were found.

In 1986, Sheldon Kindall of the Houston Archeological Society (HAS) documented and recorded several prehistoric sites that had been visited by local artifact collector Andy Kyle between 1946 and 1986. One of the Kyle sites (Site 41HN13) recorded by Kindall is located within the current project area.

In 1992 Christopher Jurgens (1992) supervised an archaeological survey that was conducted by staff archaeologists from the Texas Water Development Board designed to identify and assess cultural resources that might be affected by the proposed Lumberton Municipal Utility District State Water Pollution Control Revolving Fund Wastewater project. No evidence of cultural resources was encountered during the survey. The project is in Hardin County.

In 1997, Moore Archeological Consulting conducted an archeological survey of proposed construction areas within the Turkey Creek Unit (Jackson and Moore 1997). This survey identified an early to middle 20th century cabin (41HN17) that was being used by the forest service as visitor center. The researchers state that this site reflects patterns of homesteading during the early to middle 20th century in Southeast Texas, especially the adaptation and survival of low-income families during the Great Depression. They believe the cabin has research potential and may be eligible for listing in the National Register of Historic Places or designation as a State Archeological Landmark.

In 2001 Archaeologists from Parsons, Brinckerhoff, Quade & Douglas, Inc. (Campbell 2001) examined 23 high probability areas (525 acres) along United States Highway 69 in Hardin and Tyler counties. Previously recorded site 41HN14 was visited and evaluated. Since it was not within the highway right-of-way, it would not be affected by the proposed construction. Therefore, it was not formally assessed.

In 2003 and 2004 PBS&J archaeologists conducted an archaeological survey of the Knight II 3-D Seismic Project within portions of the Big Sandy Creek and Menard Creek Corridor Units of the Big Thicket National Preserve. Ed Baxter was the project archaeologist. A total of 25 previously unrecorded prehistoric sites and 3 previously unrecorded historic sites were documented during this investigation. All sites were avoided by seismic survey activities (Porter and Bishop 2004).

In 2006 DESCO archaeologists conducted an archeological survey within the Turkey Creek Unit of the Big Thicket National Preserve in Hardin and Tyler counties. Ed Baxter was the project archaeologist. The unit of the Big Thicket National Preserve where this study was performed consisted of 9,756 acres (3,948 hectares). The Area of Potential Effect (APE) was 1,040 acres (421 hectares). Within the APE, shovel testing was conducted at source points and drill access routes. The study recorded 15 new archeological sites. Eight were in Hardin County (41HN43 - 41HN50), and seven were in Tyler County (41TL79 – 41TL85). Thirteen sites were prehistoric, and two sites (41HN28 and 41HN48) had both a prehistoric and historic component. Two previously recorded sites (41HN16 and 41HN28) were accidentally shovel tested because they were not correctly plotted at TARL. This testing led to the addition of a prehistoric component at site 41HN28 and an increase in site size at 41HN16. Six previously recorded sites (41HN14, 41HN16, 41HN17, 41HN25, 41HN28, and 41TL59) were visited, and a site revisit form was completed for each of these sites. Two of the previously recorded sites (41HN14, and 41HN16,) were prehistoric, and three sites (41HN17. 41HN25, and 41TL59) were historic and 41HN28 was a multi-component site (Moore and Baxter 2007).

In 2008, an archaeological survey was conducted at Village Creek State Park in Hardin County by Ecological Communications Corporation for the Texas Parks and Wildlife Department (Feit et al. 2008). The area investigated covered 1090 acres and was surveyed by a crew walking in intervals of thirty meters where possible and they excavated a total of 507 shovel tests. No previously recorded sites were revealed through their background research, and no new sites were found.

In 2011 DESCO archaeologists conducted an archaeological survey on portions of the Big Thicket National Preserve for the Rivers Edge 3-D Seismic Project in Hardin, Jasper, Jefferson, and Orange counties, Texas. Exa Grubb and Ed Baxter were the project archaeologists. The project area encompassed 27.21 square miles (70.47 square kilometers) or 17,441 acres (7047 hectares). Only the Area of Potential Effect (the source point locations and the drill access routes) were investigated. As a result of this investigation, three prehistoric sites (41OR93, 41OR94, and 41OR96), two historic sites (41OR95 and 41HN53), and four localities containing prehistoric artifacts were identified. The ceramic analysis conducted by Timothy K. Perttula suggests that site 41OR93 was occupied prior to A.D. 500 during the Early Ceramic Orange period that was recently identified and named by Lawrence E. Aten and Charles N. Bollich (2011). Site 41OR94 also dates to the Early Ceramic Orange period. This site also contained evidence that it was inhabited in the Late Prehistoric period, circa A.D. 950 or later. *Friley* points date to sometime between A.D. 700 and A.D. 1100, and the presence of this artifact at site 41OR94 is consistent with the ceramics from this site. The presence of a possible *Kent* dart point at site 41OR93 is an indication that an Archaic component dating to sometime prior to 2500 B.P. may have been present. The two historic sites are canals that were created by a lumber company to provide access for steam-powered equipment used in the removal of logs from the swamps and for the transportation of log rafts to natural waterways where they were towed to the mill (Moore et al. 2012).

Numerous small surveys have been performed in the five counties of the project area mainly by cultural resources firms performing surveys for specific highway, water, sewer and oil related projects.

Project Area Previous Investigations

A search of the Texas Archeological Sites Atlas (Atlas) revealed the presence of ten area projects and ten linear projects within the current project area. One additional linear project (not on the Atlas) was discovered in the project area in Tyler County. Unfortunately, there is very little information regarding these projects. In additional to these projects Gus Arnold recorded two sites in and near the project area.

Area Projects

In October of 1978 a 625 acre (253 hectare) survey was conducted for the Federal Aviation Administration (FAA) in Angelina County, Texas. No sites were found on the Atlas in the survey area. No report on the project was found. The survey would not meet today's standards.

In August of 1983 a 5 acre (2 hectare) survey in Jefferson County, Texas was conducted for the Environmental Protection Agency (EPA). No sites were found on the Atlas in the survey area. No report of the project was found. The survey would meet today's standards.

In April of 1999 a 10,678 acre (4,321 hectare) reconnaissance survey for a seismic project was performed by Blanton and Associates in the Lance Rosier Unit of the Big Thicket National Preserve, Hardin County, Texas. Only seismic lines were investigated so the entire acreage was not surveyed. David Brown was the Principal Investigator and report author. No sites were found during the survey and four previously recorded sites, 41HN22, 41HN39, 41HN40 and 41HN42 were discussed. The survey would meet today's standards.

In December of 1999 a second reconnaissance survey for a seismic project was performed in the Lance Rosier Unit of the Big Thicket National Preserve in Hardin County, Texas. The survey totaled 1,030 acres (417 hectares). Only seismic lines were investigated so the entire acreage was not surveyed. No sites were found during the survey. This survey overlaps the earlier survey and was presumably performed by Blanton and Associates however no report has been found. The survey would meet today's standards.

In April of 2001 a 3 acre (1 hectare) survey was performed for the National Park Service in the Lance Rosier Unit of the BTNP, Hardin County, Texas. No report has been found but the aerial shows a well pad at the location. No sites are shown on the Atlas in this survey area. The survey would meet today's standards.

In May of 2006 a 239 acre (97 hectare) survey was performed in Angelina County, Texas by W.J. Bennett for the USACE, Fort Worth District. The client was AMC Paragon Inc., Houston. No sites were found on the survey. The survey would meet today's standards.

In March of 2007 the 413 acre (167 hectare) Clarity Pipeline Survey was conducted in Hardin and Orange counties, Texas for the USACE, Galveston District by HRA Gray and Pape, LLC. The principal Investigator was Kristi E. Turner who authored the report with James Hughey. The client was URS Corporation, Houston, Texas. Two sites, 41HN51 and 41HN52

were found. Site 41HN51 was recorded as a multicomponent site consisting of historic material associated with the Sabine and East Texas Railroad that was constructed in 1882 and a prehistoric lithic dart point. The site is on Cypress Creek. Historic artifacts mentioned included brick fragments, tar, nails, glass, shell casings, metal fragments, and clay mortar. Historic features included a trestle bridge, concrete structures, and a buried concrete pad. The form states that research potential is high for gathering functional data of structures associated with the railroad. Site 41HN52 was reported as an unknown prehistoric lithic scatter with no diagnostic artifacts on a low sand ridge 0.2 miles west of Village Creek. National Register testing was recommended for 41HN51. Neither site is near the current project area. The survey would meet today's standards.

In April 2007, PBS&J conducted an intensive survey for terrestrial cultural resources for the Energy Transfer Company Katy Pipeline Ltd.'s proposed HPL 24-inch Trunkline Lateral Pipeline Project. The survey was limited to the 100-year floodplain within the survey corridor, plus an additional 300 foot (100 meters) distance from the floodplain onto the first terrace. Three jurisdictional areas were surveyed. The proposed project consisted of approximately 19.5 miles (31.4 kilometers) of new 24-inch-diameter natural gas pipeline in Tyler and Hardin counties, Texas. PBS&J conducted cultural resources surveys within a corridor that measured approximately 250 feet (76 meters) in width centered along the proposed pipeline centerline. A total of approximately 823 acres (333 hectares) measuring 32.1 miles (51.6 kilometers) were surveyed during this project.

No archaeological sites were located during fieldwork for this cultural resources survey. No impacts to cultural resources that are eligible or potentially eligible for listing in the National Register of Historic Places were anticipated as a result of the proposed pipeline construction activities (LeFevre and Norton 2007). The survey would meet today's standards.

In August, 2007, a 62 mile (100 kilometer) long, 7883 acre (3,190 hectare) pipeline survey was conducted in Jefferson County, Texas for the USACE, Galveston District. The survey was performed by SWCA Environmental Consultants with Kevin Miller as the Principal Investigator and Michael Crow and L. Falcon were the authors. The project was for Air Products c/o Mustang Engineering. No sites were found. The survey would meet today's standards.

In March and November 2008, the Archaeological Survey of Portions of the Proposed Denbury Green Pipeline,-Texas, LLC - 24-Inch CO2 Pipeline Project, Calcasieu Parish, Louisiana and Orange, Jefferson, Chambers, Galveston, and Brazoria Counties, Texas, (Crow et al. 2009) for the USACE, Galveston District was conducted by SWCA. Michael Crow was the Principal Investigator. The client was Danbury Onshore. Investigations were limited to designated Affected Project Areas (APAs), including terraces/floodplains adjacent to natural relatively intact potential USACE jurisdictional waterways crossed by the Project and portions of the Project area adjacent to previously recorded cultural resources. SWCA identified and proceeded to investigate a total of 52 APAs accounting for approximately 210 acres (85 hectares). Of this, approximately 24 acres (9.7 hectares) was in Calcasieu Parish, Louisiana and 186 acres (75.3 hectares) was in Orange, Jefferson, Chambers, Galveston, and Brazoria counties, Texas. Between April and November 2008, two to four archaeologists completed survey of 51 of the APAs utilizing shovel tests and available exposures. In general,

investigations were conducted within an approximately 110 foot (33.5 meters) wide survey corridor with APAs averaging approximately 1,600 feet (500 meters) in length. Investigations included an intensive pedestrian survey and excavation of 376 shovel tests. Two shovel tests (less than one percent) were positive for cultural materials. Overall, investigations revealed a low potential for intact cultural deposits in the project area. No new sites were found during the survey and the positive shovel tests were investigating previously recorded sites. No sites were located in the GOM project area counties. The survey would meet today's standards.

Linear Projects

In May of 1972 a boat survey was performed by the USACE, Galveston District along Taylor Bayou and the North and South Forks of Taylor Bayou. No sites were found in the project area however several shell middens were located further downstream along the bayou. The survey was conducted by Carolyn Good. Charlie Bollich was the local informant for the project. Four prehistoric shell midden sites were recorded on Taylor Bayou. These were 41JF51, 41JF52, 41JF53, and 41JF54. The closest of these, 41JF51 is 4.5 miles (2.4 kilometers) east of the project area. Site forms are dated 1983. No report of the project was found. The survey would not meet today's standards.

In December of 1975 a 7.7 mile (12.39 kilometer) survey was conducted along highway 73 by the Texas Department of Highways and Public Transportation (TDHPT) in Jefferson County, Texas. No sites were found on the Atlas along this route. No report of the project was found. The survey would not meet today's standards.

In May of 1976 a water pipeline survey was conducted by Hayden Whitsett working for the Texas Water Quality Board (TWQB). The survey was for the EPA. The project was in Angelina County, Texas. Whitsett discovered one prehistoric site, 41AG52. The site was identified as a few flakes lying in an exposed road cut on a bluff crest. The site is on property owned by the Texas A&M Experimental Tree Farm in Hudson. He also investigated two reported locations of 41AG22, a Gus Arnold site that reportedly had a Caddo mound in which a burial, a gun, and beads had been excavated. At one location he found a natural mound but no evidence of cultural remains. No report of the survey was found. The survey would not meet today's standards.

In June of 1976 a survey was conducted by the TDHPT in Hardin County, Texas. The survey covered 8.6 miles (13.8 kilometers) along Highway 421. No sites were found on the Atlas along this route. No report was found. The survey would not meet today's standards.

In 1977 a 15.5 mile (24.9 kilometer) pipeline survey was conducted for the Department of Energy (DOE) in Jefferson County, Texas. The Atlas shows that no sites were recorded along the route. No report was found. The survey would not meet today's standards.

In January of 1979 a survey was conducted for the USACE, Galveston District in Jefferson County, Texas. This was a pipeline survey and the Atlas shows that no sites were recorded along its corridor. No report was found. The survey would not meet today's standards.

In March of 1981 a survey was conducted for the McFaddin Wildlife Refuge in Jefferson County, Texas. The survey was conducted by Clell Bond and Ed Baxter along a 6.5 mile (10.5 kilometer) long, 60 foot (18.2 meters) wide corridor. No sites were found. The survey would meet today's standards.

In September of 1982 a linear project, shown on the Atlas, along Highway 87 was performed by the TDHPT in Chambers and Jefferson counties, Texas. It is believed this was the survey that John W. Clark conducted when he reported 41JF50 in 1978 (the McFaddin Beach site) and that the report was completed in 1982. This survey is the only one on the Atlas for this area. The survey would not meet today's standards.

In September of 1994 a 4.3 mile (6.9 kilometer) survey was conducted along Highway 1003 for the Federal Highway Administration (FHWA) in Hardin County, Texas. No sites were found on the Atlas along this route. No report was found. The survey would meet today's standards.

In May of 1996 a 6 mile (9.7 kilometer) long survey was conducted along US 190 in Tyler County, Texas by TXDOT archaeologists. One prehistoric site, 41TL46 was found on the toe of an upland slope on the western margin of the Big Cypress Creek floodplain. Pages one and four of the site form are missing therefore the recorder and form date is unknown. The only artifacts found were two undecorated potsherds recovered at 20 centimeters below surface (cmbs) from a single shovel test. Four additional shovel tests found no artifacts. The site was recommended as not eligible to the National Register of Historic Places. The survey was recorded in a letter report that can be found in TxDOT, THC Volume II, Tyler County. The survey would meet today's standards.

In 2006 Victor Galan of the Deep East Texas Archaeological Consultants conducted a survey of the Pogo pipeline in Tyler County on the 7.5 min. USGS Chambliss Hill quadrangle on the east side of Big Cypress Creek. One site, 41TL86 was found. Artifacts recovered included four flakes, one biface, and one plain sherd. The site had been very disturbed by logging activities, pipeline construction and a road. It was stated there was no research value to the site and that the National Register of Historic Places eligibility was unknown. The site is 700 meters east of the centerline of the seismic corridor. The pipeline survey does not appear on the Atlas. The survey would meet today's standards.

PREVIOUSLY RECORDED SITES IN AND NEAR THE PROJECT AREA

The records check at TARL and the Atlas sites database of the THC only found two previously recorded sites within the half-mile corridor (one fourth mile along each side of the centerline). An area within 1/2 mile on either side of this corridor boundary was then checked for previously recorded sites resulting in the addition of only four more sites. This was done in order to determine what types and frequency of sites existed near the corridor. Together these sites represent the total number sites recorded within 1.25 miles on either side of the proposed seismic line.

Sites within the Project Corridor

41AG2

Site 41AG2 was reported by G. E. Arnold sometime in the 1940s. The site is in Angelina County on the 7.5 minute USGS Clawson quadrangle about 3.5 miles north of Pollock, Texas. The site size was reported as about 1/2 acre on the top of a sandy ridge overlooking bottomland to the east. It was reportedly the location of an old Indian burial ground according to Mrs. Brewer of Pollock whose grandfather had pointed it out to her. It was reported that several men with a Dr. Crawford excavated test pits to determine any evidence of burials but they left no written record of their findings. Arnold visited the site and examined the pits and found no evidence of burials or any artifacts. The site's eligibility for listing in the National Register of Historic Places is unknown.

41JF50

McFaddin Beach Site was officially recorded as a site in 1978 when John Clark of the Texas Highway Department visited it and completed a site form. He recorded the site to be a narrow band running along approximately 7.5 miles of beach on the 7.5 minute USGS Clam Lake, Mud Lake, Star Lake, and South of Star Lake quadrangles.

Prior to this time, the site had been known for years due to the large number of Paleo-Indian projectile points and Pleistocene faunal remains that were exposed on the beach at low tide and found by local collectors. The origin of the artifacts was believed to be from a shallow reef or bank about 20 to 40 meters offshore. Two of the earliest collectors were Odis and Beverly Beckham who visited the site in 1961 after hurricane Carla. Russell J. Long (1977) produced a monograph published by the Spindletop Museum entitled *McFaddin Beach*. Much of Long's work was based upon one of his graduate students, Jeffrey Russell, Master's thesis at Lamar University. Mr. Russell described and inventoried the artifacts and fossils from the various collections from the beach.

In 1991, a conference was organized by Dee Ann Story, Paul Tanner, and Ellen Sue Turner. Several local collectors brought their collections to the conference. Results of this conference were that professionals in several disciplines took note of unique attributes of this area. An article in the *Bulletin of the Texas Archeological Society* entitled The McFaddin Beach Site was authored by Sue Ellen Turner and Paul Tanner (1994).

Melanie Stright, an archeologist with the Minerals Management Service of the United States Department of the Interior, began a detailed study of five of the best-documented collections. Her study examined approximately 880 artifacts, approximately a third of the artifacts known from the site at the time. She examined sources of stone used to make the tools, degree of wear, re-sharpening, the spatial position of the artifact along the beach, ages of the artifacts based on tool typology, and functional classes of artifacts. Her study (Stright et al. 1999) remains the chief source of information on the site.

Only a 1/2 mile section of the site is within the current project area. This section is on the 7.5 minute USGS Clam Lake quadrangle. The National Register of Historic Places eligibility is listed as potentially eligible.

Sites within One-Half Mile of the Project Corridor

Site 41AG21

This site was recorded by G.T. Arnold (presumably in the 1940s) in Angelina County on the 7.5 minute USGS Lufkin quadrangle on the east side of Cedar Creek. It was described as a prehistoric Indian site 1 acre in size, on top of a sandy ridge overlooking bottomland. He gathered 64 potsherds and reported that potsherds and projector points have been found on the site. No National Register of Historic Places eligibility was given. The site boundary is 800 meters east of the centerline of the seismic corridor.

Site 41HN13

This site was recorded by Sheldon M. Kindall in 1986 in Hardin County on the 7.5 minute USGS Village Mills quadrangle. The site is a prehistoric Indian camp on high ground overlooking Village Creek to the north. The site was recorded during a Houston Archeological Society summer survey project and is one of the many sites from which Andy Kyle collected points between 1946 in 1986. No site size was given. No National Register of Historic Places eligibility was given. The site boundary is 840 meters east of the centerline of the seismic corridor.

Site 41TL46

This prehistoric site was recorded by The Texas Department of Transportation (TXDOT) on a survey of U. S. Highway 190 in Tyler County, Texas. It is located on the 7.5 minute USGS Chambliss Hill quadrangle at the toe of an upland slope on the Western margin of the Big Cypress Creek floodplain. Pages one and four of the site form are missing therefore the recorder and date is unknown, however a review of the linear projects within the project area determined their survey was conducted in May of 1996. The only artifacts found were two undecorated potsherds recovered at 20 cmbs from a single shovel test. Four additional shovel tests found no artifacts. No site size was given. The site was recommended as not eligible to the National Register of Historic Places. The survey was recorded in a letter report that can be

found in TxDOT, THC Volume II, Tyler County. This site is 700 meters west of the centerline of the seismic corridor.

Site 41TL86

This unknown prehistoric site was recorded by Victor Galan of the Deep East Texas Archaeological Consultants in 2006 during the Pogo Pipeline Project. It is located in Tyler County on the 7.5 minute USGS Chambliss Hill quadrangle on the east side of Big Cypress Creek. Artifacts recovered included four flakes, one biface, and one plain sherd. Site size was projected to be 75 meters by 10 meters. The site had been very disturbed by logging activities, pipeline construction and a road. It was stated there was no research value to the site and of the National Register of Historic Places eligibility was unknown. The site is 700 meters east of the centerline of the seismic corridor.

TOWNS AND COMMUNITIES

The information on the following towns and communities was taken from the Handbook of Texas Online.

Chester, Texas is located in the extreme northwestern portion of Tyler County on the 7.5 minute USGS Chester quadrangle. It is a part of a five league grant made to the Gavino Aranjo on the old road from Nacogdoches to Liberty. The town was started in 1883 when the Trinity and Sabine Railway routed its new line 1 mile South of Peach Tree village. The Peach Tree Village post office and Mount Hope Masonic Lodge moved to the new location by the railway. The town grew with a blacksmith shop, a boarding house and a large hotel. By 1890 the town had a saw mill, a school, two cotton gins, and two churches. The town's population ranged from 176 in 1904 to 250 during the mid-1920s to the mid-1940s, then rose to 350 and sustained that level until the late 1960s when it dropped to around 260. By 1980 the population had risen to 301 and by 1988 to 409. Its population then began declining and was only 265 people by 2000 (Biesele n.d.a).

Peach Tree Village, Texas is located in northern Tyler County two miles north of Chester, Texas. The village was settled by the Alabama Indians when they began moving into East Texas in the early 1800s. Samuel Davenport, an Indian Agent, reported that the Alabama's established the principle town, Peach Tree Village, on the west bank of the Neches River eight leagues above the confluence with the Angelina River. The village was an early crossroads with the Alabama Trace and the Coushatta Trace running east-west and Long Kings Trace which ran north-south. White settlers moved into the area and the community gradually transformed from an Indian village to a Texas frontier town. The settlers contested the Indians' claim to the land resulting in the Alabama's leaving Peach Tree Village during the Republic of Texas era and moving 5 miles southwestward to the Fenced-in Village. By the 1850s Peach Tree Village had a post office, a cotton gin, a saloon, a church, and a school and a doctor's office. The village was the birthplace of John Henry Kirby who later established the Kirby Lumber Company. In the 1880s the Trinity and Sabine Railway was constructed near this area. As a result, the towns businesses along with the Postal Service were moved to the rail line one mile south and the village of Chester was established. Currently 22.4 acres of the Peach Tree Village site is a nondenominational Christian camp (Martin, Handbook of Texas Online).

Pine Island, Texas is located in northern Jefferson County eleven miles west of Beaumont. Originally the town was located 2 miles north at the site of the present Westbury. It had a post office by 1839 which, although subsequently discontinued, operated again from 1849 to 1867. An 1888 map shows Pine Island on the railroad south of the original location. The post office was reopened in 1904 and discontinued in 1912. The population was 350 in the year 2000 (Wooster, Robert n.d.).

CEMETERIES

There are three cemeteries in the project area corridor. All are in Angelina County. They are discussed below, and their locations have been plotted on the avoidance plan map (Appendix I).

Hoshall Cemetery is designated as AG-C094 and is located on the 7.5 minute USGS Keltys quadrangle on Farm-to-Market 324 0.8 miles north of State Highway 59. It is also known as Bitterweed Flat Cemetery. It measures 40 feet by 80 feet and has ten graves recorded dating from 1900-1945.

McCall Family Cemetery is designated as AG-C095 and is located on the 7.5 minute USGS Keltys quadrangle on an unnamed two-track road 0.5 miles south-southwest of the intersection of Farm-to-Market 324 and old Highway 59. It measures 60 feet by 90 feet and has ten graves recorded dating from 1860-1900, 1900-1945, and 1945-1975.

Old Union Cemetery is designated as AG-C047 and is located on the 7.5 minute USGS Keltys quadrangle on Old Union Road (Farm-to-Market 1271) at the Old Union Church. This is 1.25 miles west of the junction of West Loop 287 and Pershing Road (Old Union Road/FM1271). It measures approximately 4 acres (460 feet by 475 feet). The number of graves and grave dates are not listed.

RESULTS

The following buffers have been drawn on the project area maps that will be submitted to the USACE, THC, GXT and Cougar Land Services, LLC. A buffer of 50 meters (164 feet) has been placed around cemeteries and archaeological sites (Appendix I). These buffers are consistent with the guidelines set forth by the USACE and the THC. On the GXT and Cougar Land Services, LLC maps the archaeological site buffers will be incorporated into the HPA.

Development of High Probability Areas

Appendix I depicts the high probability areas for cultural resources. These designations are based on reviews of historic literature, topographic maps, historic maps, previous surveys, and the identification of geomorphic features discussed in the *Environmental Section*. Prehistoric archaeological sites in the inland part of Southeast Texas are typically found on sandy hills and terraces adjacent to natural lakes, rivers, and streams that contained water in prehistoric times. Most habitation sites are not visible on the surface except when disturbance has exposed the subsurface. Often, this is the result of erosion, construction, and cultivation. All shorelines along natural waterways such as rivers, lakes, and streams have been designated for this project as high probability areas for at least 100 feet inland. Specific geomorphic situations may increase this area. It is difficult to predict high probability areas based on previous surveys because few investigations have been conducted by professional archaeologists in the project area, and most surveys did not find any sites.

Areas of high probability for historic sites were drawn in areas around the settlements, structures found on the historic maps, and areas identified through historical documents.

Nautical high probability areas were obtained from Amy Borgens, the State of Texas Nautical Archaeologist.

Appendix I depicts the site and cemetery buffers; high probability areas based on the topographic maps, results of previous surveys, local informant interviews; and the identification of geomorphic features of the project area.

MONITORING METHODS

The proposed monitoring will consist of an archaeologist being present when any drilling is performed near any cultural resource buffer and visual inspections and/or shovel testing of any source point placed within the high probability areas identified during pre-field tasks as discussed in the *Research Methods* above and depicted in the Appendix I map.

As per this plan, the source point investigation portion of the monitoring activities will be performed in accordance with criteria established by the Council of Texas Archeologists (CTA). At each proposed source point location, field crews will visually inspect the ground surface and (where appropriate) excavate one shovel test to determine if buried cultural materials exist. Shovel tests will be excavated to a depth of one meter or until water or clay is encountered.

Where cultural materials are recovered at these proposed source point locations, crews will perform delineation activities to determine the site boundaries by excavating additional shovel tests in all four cardinal directions at intervals of ten meters (33 feet). A site boundary will be determined when two consecutive, negative shovel tests are excavated in each of the four directions or where water bodies prohibit testing. Shovel tests will be excavated in 10-centimeter levels to a depth of one meter or until water or clay is encountered. Archaeological site boundaries will be buffered by 50 meters (164 feet), and any source point (unless previously drilled) within these buffers will be relocated. A shovel test will be excavated at any of the relocated source points moved within the high probability area and the process mentioned above will be repeated if artifacts are found.

A field number will be assigned to any newly discovered site, and a site form will be submitted to the TARL so a State of Texas site number can be assigned. All newly discovered cultural resource sites would be avoided by the project so any National Register eligibility determinations will not be needed.

A monitoring report will be prepared and submitted to the USACE and the THC when the seismic project is completed.

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APPENDIX I

AVOIDANCE PLAN MAPS

APPENDIX II

DESCRIPTION OF SEISMIC METHODS

APPENDIX II

DESCRIPTION OF OPERATIONS

The purpose of the proposed 2D survey is to provide ultra-long offset refraction measurements to develop an understanding of the deep crustal velocity structure to aid in the imaging of subsurface geology that encompasses a project area approximately 412 miles long, of which, 273 miles occurs within the Gulf of Mexico. Seismic surveys are conducted by directing a seismic wave, generated by an energy source, into the subsurface of the earth and recording the reflection of that wave back on the earth's surface. The intensity and timing of the reflected wave are used to map the subsurface geologic features to the desired depth, and these maps are used to assess the absence/presence and location of oil and gas reserves deep below the earth's surface. The project is anticipated to begin in July 2012 and it is estimated that approximately six months will be required to complete operations within the entire project area. However, there will not be a constant presence in any one area for the duration of the project. Operations will progress from south to north as shot holes and receiver locations are surveyed and demarcated, shot holes are drilled, and sources are detonated and recorded in this order. Each of the three primary activities (i.e. surveying, drilling, and recording) will be temporary and of short duration at any given location within the project area.

The primary energy source for this project on land will be explosive charges (e.g. *Pentolite*). The charge depth and configuration proposed consists of single, 80-foot deep holes (i.e. shot hole) drilled at intervals of 250-meters (820-feet) along each source line, alternating with two 150-foot deep holes drilled at intervals of 1,000-meters (3,280-feet). Each source location, or shot hole, within these areas will be loaded with either a 5.5-pound (80-foot) or 27.5-pound (150-foot) explosive charge and will be plugged in accordance with state regulations to prevent the mixing of surface and groundwater. Within the McFaddin NWR, shotholes will be loaded within only 5.5-pound charges. Based on pending comments from the Railroad Commission of Texas (RRC), shothole depths within portions of Jefferson County will be limited to depths of approximately 100-feet as to not interfere with existing groundwater supplies. Motion-sensing devices, known as receivers or geophones/hydrophones, will be spaced out along the receiver line at intervals of 100-meters (328-feet).

Low-impact seismograph equipment will be utilized to ensure maximum protection of fish, wildlife, and their respective habitats. The shot hole drilling equipment may include drill-mounted buggies, airboats, and lightweight tracked vehicles. In upland locations, articulated track drills may be used. Recording equipment will include recording instrumentation, geophones, hydrophones, cables, batteries, GPS-based navigation systems, ATVs, airboats, light-weight tracked vehicles, and a helicopter(s) for transport of equipment and personnel. The specific equipment type used at any given location will be determined as the least intrusive for the habitat type and observed real-time conditions.

Whenever possible, the layout, troubleshooting, and pick-up of receiver stations will be carried out on foot. A helicopter equipped with a long-line will be used to deploy and recover recording equipment to and from the 2D line. Shot hole drilling rigs mounted on buggies, airboats, or tracked vehicles will be used during the entire survey within the MNWR. Based on doubling the

maximum width of the equipment and allowing for offsetting equipment tracks near the 2D line, we would propose a 100-foot (50-feet to either side of the line) corridor for operations.

Project activities will commence with civil survey crews visibly marking the proposed locations of source holes and receiver points with survey lathes and flagging and cane poles. Locating source and receiver locations will be accomplished using global positioning system (GPS), inertial, and/or conventional surveying methods. Crews will appropriately re-locate any source points that conflict with previously unidentified structural and/or sensitive resources at this time. Clearing of vegetation on land may be necessary to obtain line-of-sight for conventional surveying and/or to allow for the safe passage of crews along the seismic line. The cutting of brush, small trees (less than 3-inch diameter at 12-inches aboveground), and branches, would be accomplished through the use of machetes or brush hooks. Cutting will be limited to the minimum amount necessary to accomplish line-of-sight objectives.

Once an appropriate number of source holes have been marked, drilling operations will begin. Drilling will be accomplished using buggies in dry, upland areas; airboats in open water or shallow/marsh areas that are inundated; and tracked, lightweight marsh buggies in dry marshes, as real-time conditions dictate and the methodology best served for the conditions encountered. During the drilling phase of operations, drills would maneuver from source point to source point utilizing the route of least resistance to minimize impacts to vegetation. Additionally, equipment will minimize the number of passes to only those necessary and avoid the duplication of paths within marsh environments. No mechanized clearing will be conducted ahead of the drilling equipment. Small trees and shrubs may be impacted in the paths of the drills. A 4-inch diameter hole will be vertically drilled at each source point location and either a 5.5-pound or 27.5-pound explosive charge will be loaded to the bottom of the hole. Holes will be backfilled with as much of the cuttings as practicable and plugged with bentonite (natural clay) in accordance with standard industry practices and agency regulations for the prevention of the commingling of surface and groundwater.

The critical zones for seismic equipment passage include areas of sparse vegetative ground cover or areas with saturated soils. The use of appropriate seismic equipment for each situation will be performed. Minimal disturbance to soils and vegetation is a primary goal of the project.

Once an appropriate number of source holes have been drilled, recording operations will commence and progress as drilling continues. Recording operations will be supported by helicopter to minimize impacts. Helicopters will lower cache bags containing equipment along the 2D line, and crews on the ground will deploy the equipment along the line.

Recording equipment will consist of geophones/hydrophones, cables, and data recording boxes (set directly on the ground or floated in open water). Once enough equipment is laid out to complete a recording, the recording crew will proceed with detonating shot holes. Crew members will travel between source point locations, connect a shooting pack to each electronic detonating wire (cap), and detonate each charge. The resulting reflected energy wave will be measured by the geophones/hydrophones and recorded. Recording operations will be coordinated from an approved field location (more than one will be needed) suitable for the entire project.

Clean-up will be conducted in conjunction with recording operations. After the charges are detonated and recording is completed in each swath, all equipment, trash, and flagging will be picked up from the area and placed in cache bags for removal by crews, helicopter, or light-weight vehicles, or other appropriate means.

Impacts from drilling and detonation of shotholes are minimal and are considered temporary in nature. Similarly, impacts from equipment travel are typically minimal, short-term, and confined to the source and receiver points. Vegetation typically recovers along the line within one to two growing seasons. Equipment best suited to the habitat being affected will be utilized in an effort to minimize impacts to these areas.

APPENDIX B
Actions for the Identification and Protection of Colonial Waterbird Nesting Areas

APPENDIX B
Gulf of Mexico LithoSpan Phase I 2D Seismic Survey

Actions for the Identification and Protection of Colonial Waterbird Nesting Areas

Identification

Colonial waterbird nesting area (rookery) identification within the Gulf of Mexico LithoSpan Phase I 2D seismic survey will include planning, surveying, and monitoring components, applicable within the nesting season (between February 15 and September 1).

Planning incorporates information obtained from state natural heritage databases as well as additional local, state, and federal agency information on historic rookery locations within and immediately adjacent to the project area. There are no known historic rookery locations within the project area; however, based on discussions with McFaddin NWR biological staff, they have requested potential nesting areas be identified. Aerial and/or color infrared aerial photography would also be utilized to pinpoint potential rookery locations and areas of interest outside of known historic locations.

Survey efforts would consist of ground and/or aerial surveys, focusing on areas of interest identified during planning, and other potentially suitable habitat present within the project area. In areas with few easily accessible ground or water access routes, aerial transects utilizing a helicopter typically yield the most accurate results with the least amount of impact. Transect spacing and altitude are condition-dependent on visibility at the time of survey. Typically, transects within a coastal environment are spaced between 500 feet and 1,000 feet apart, and are accomplished from an altitude of approximately 1,000 feet. Rookery boundary information would be gathered while surveying to ensure that the entirety of the nesting area is protected, rather than just applying a buffer to the center point of the rookery. Rookery boundaries would be determined by taking GPS measurements of the perimeter of the nesting area (if possible at an altitude of at least 1,000 feet), or by utilizing recent aerial photography in conjunction with at least one GPS position and field observations for smaller nesting areas.

Monitoring would also play an important role in rookery location and identification. Rookery locations can be difficult to predict and can establish within the project area at any time throughout the nesting season; therefore, additional monitoring for and assessment of new rookery sites will be necessary. This topic would be addressed at all crew start up meetings and during daily safety meetings to inform crews of the importance of identifying and offsetting away from all rookery locations. Crew awareness will aid in the identification of new rookery locations. Project compliance and biological monitors would also document any new rookery sites identified during monitoring efforts and insure their protection. Periodic follow up surveys would be conducted in advance of operations in potentially suitable nesting habitat throughout the duration of the nesting season to assist in rookery protection and project planning.

Previously identified rookeries within active portions of the project area would also be periodically monitored to ensure the protection buffer is being observed by all crews and is adjusted accordingly to incorporate any growth in nesting areas.

Protection

Protection of rookery areas will include the assignment of a minimum 1,000 foot avoidance buffer to the outermost limits of each active rookery island/location. No seismic activities would occur within this buffer zone. Buffers would be defined using the data collected during survey and monitoring efforts, and would be incorporated into all seismic survey crew maps to aid in crew avoidance during the nesting season.

Project compliance and biological monitors would observe rookery areas during operations to ensure that disturbance to rookeries from 2D seismic activities is not occurring. Should monitors observe disturbance from crew activities located more than 1,000 feet away from rookery locations, the monitors would consult with TPWD and USFWS to determine adequate buffers for protection of nesting birds, and adjust rookery buffers accordingly.

In the event of rookery establishment within an active portion of the project area, (i.e. after surveying and/or drilling phases but before recording), coordination with resource agencies would be initiated to determine appropriate protection measures. In previous projects, effective protection measures in such cases have involved allowing for recording operations using flatboats or airboats at idle speed within 1,000 feet of rookery locations with incorporation of additional monitoring to insure that disruption of nesting birds does not occur. Should birds appear to be disturbed by recording activities, the activities would be abandoned in the area until after the nesting season.

Evaluation of the 1,000 Foot Avoidance Buffer

The establishment of a 1,000 foot protection buffer from waterbird nesting areas is standard for seismic surveys, and has been implemented within previous seismic programs that DESCO has been involved with by USFWS and other state and federal agencies.

In past seismic projects, the 1,000 foot protective buffer has been observed by DESCO to be an effective distance to prevent disturbance to breeding colonial waterbirds. Activity within a seismic survey is phased, with only a limited amount of activity occurring adjacent to rookery locations at any given time. Overall, seismic surveys have a short duration of activity within any given area as the survey progresses in comparison to many construction projects that create disturbances within more localized areas and for longer durations. The effectiveness of a 1,000 foot protection buffer is also collaborated by research, including that conducted by Rodgers (1994), in which disturbance from airboat activity was measured. Average flush distances from airboat approach ranged from 73.3 meters to 143.7 meters. As a conservative approach, Rodgers (1994) recommends an offset of 300 meters for airboat activity.

Rodgers, James. 1994. *Minimum Buffer Zone Requirements to Protect Nesting Bird Colonies from Human Disturbance.* Wildlife Research Laboratory, Florida Game and Fresh Water Fish Commission.

APPENDIX C
Marsh Habitat Monitoring Criteria and Aerial Image Protocol

APPENDIX C
Gulf of Mexico LithoSpan Phase I 2D Seismic Survey

Marsh Habitat Monitoring Criteria and Aerial Image Protocol

1. GX Technology (GXT) will use aerial photography with GIS analysis to monitor the MNWR permitted area (PA). The purpose of the GIS analysis is to quantify habitat loss and conversions, particularly emergent marsh to open water. The PA will be monitored by providing pre- and post- project aerial photography taken before seismic activities begin, then 2, 12 and 24 months post project completion to allow for two seasons of vegetative re-growth.

2. During seismic surveying, equipment paths will be tracked with GPS recorders placed on all equipment to accurately record survey locations. These coordinates will be overlaid on the pre- and post-project aerials. GXT will then utilize GIS to conduct an analysis to determine the amount of vegetated marsh permanently impacted by survey activities.

3. Permanent impacts within the PA will be defined as a net loss of vegetated marsh (amount converted to open water) at the end of the 24 month period.

4. GXT will submit 3 separate monitoring reports detailing the results from the pre- and post- GIS analysis within 90 days after the completion of each set of aerial photograpy taken 2, 12, and 24 months post project completion.

5. In addition, a third party biological observer will be present to monitor the entire PA during surveying activities. These on-site monitors will immediately identify habitat damages if any occur during daily activities. These areas will immediately be restored and monitored post project and documented in the 3 reports.

6. The aerial imagery will be color infrared, ortho-corrected, with 1-meter resolution. The aerial imagery would depict the area between the Perkins Levee (west boundary) and Clam Lake Road (eastern boundary) with the proposed 2D line located in the middle of the aerial imagery. The scale of the aerial imagery will be 1 inch = 200 feet.

APPENDIX D
Permit Authorizations and RRC Rule 100

DEPARTMENT OF THE ARMY
GALVESTON DISTRICT, CORPS OF ENGINEERS
P. O. BOX 1229
GALVESTON TX 77553-1229

July 30, 2012

REPLY TO
ATTENTION OF:

Evaluation Section

SUBJECT: Permit SWG-2012-00287; Nationwide Permit (NWP) Verification

Mr. Ray Wall
GX Technology
2150 City West Boulevard, Suite 900
Houston, Texas 77042

Dear Mr. Wall:

This is in reference to your request, dated March 28, 2012, submitted on your behalf by Dixie Environmental Services Company, LP, to conduct 2-dimensional seismic activities. This verification is valid provided the activity is compliant with the enclosed NWP General/Regional Conditions and the Texas Commission on Environmental Quality's Best Management Practice Guidelines. The project site is located in wetlands and waters of the United States along a corridor beginning at the Gulf of Mexico and continuing inland for approximately 129 miles, within Jefferson, Hardin, Tyler, Polk, and Angelina Counties, Texas.

Nationwide Permit 6 authorizes survey activities including core sampling, seismic exploratory operations, plugging of seismic shot holes and other exploratory type bore holes, soil survey and sampling activities.

This verification expires 2 years from the date of this letter. A copy of your plans, in 47 sheets, is enclosed. The following special conditions have been added to your authorization:

1. The applicant shall adhere to the requirements of Attachment A titled, "Project Design Features for the Protection of Sensitive Resources Gulf of Mexico Lithospan Phase I 2-D Seismic Project in Southeast Texas and the Gulf of Mexico (SWG-2012-00287)."

2. The applicant shall adhere to the requirements of Attachment B titled, "An Archaeological Sensitive Area Avoidance Plan for the Gulf of Mexico Lithospan Phase I 2-D Seismic Project in Southeast Texas and the Gulf of Mexico", that outlines the cultural resources areas to be avoided dated 2012, and prepared by Ed Baxter, and Exa M. Grubb. The applicant shall have a monitor present during the seismic survey as outlined in the avoidance plan and shall provide a summary of the monitoring work in a technical report to the USACE Staff Archeologist and the Texas State Historic Preservation Officer.

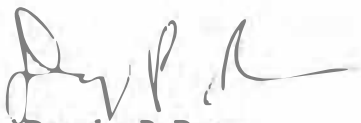
3. Should restoration of pre-construction contours be determined to be unsuccessful by Corps, the permittee will be required to take necessary corrective measures, as approved by the Corps. Once the corrective measures are completed, the permittee will notify the Corps and a determination will be made regarding success of the restoration.

This letter is based on a preliminary jurisdictional determination (JD) for your subject site. If you wish, you may request an approved JD (which may be appealed), by submitting a written request to us within 30 days from the date of this letter. Please note that if you request an approved JD and then decide to appeal it, the appeal will not be accepted if any work has started in waters of the U.S. or that would alter the hydrology of waters of the U.S.

Corps determinations are conducted to identify the limits of the Corps Clean Water Act jurisdiction for particular sites. This determination may not be valid for the wetland conservation provisions of the Food Security Act of 1985, as amended. If you or your tenant are U.S. Department of Agriculture (USDA) program participants, or anticipate participation in USDA programs, you should request a certified wetland determination from the local office of the Natural Resources Conservation Service prior to starting work.

If you have any questions regarding this verification, please contact Ms. Kristy Farmer at the letterhead address or by telephone at 409-766-3935. Please notify the Chief of the Compliance Section in the Galveston District Regulatory Branch, in writing, at the letterhead address, upon completion of the authorized project.

FOR THE DISTRICT COMMANDER:



Douglas P. Boren
Leader, Central Evaluation Unit

Enclosures

Copies Furnished:
(See Page 3)

Copies Furnished:

Mr. David M. Young, Dixie Environmental Services Company, LP, P.O. Box 1490, Magnolia, Texas 77353

Mr. Bruce Fulker, Cougar Land Services, LLC, 10701 Corporate Drive, Suite 377, Stafford, Texas 77477

Ms. Rebecca Murphey, Bureau of Ocean Energy Management, 1201 Elmwood Park Boulevard, New Orleans, Louisiana 70123-2394
Rebecca.Murphey@boem.gov

Eighth Coast Guard District, New Orleans, LA

Texas General Land Office, La Porte, TX

Texas General Land Office, Austin, TX

U.S. Fish and Wildlife Service, Houston, TX

Houston/Galveston Resident Office, Galveston, TX

GX Technology
2-D seismic survey
Jefferson, Hardin, Tyler, Polk, and Angelina Counties
SWG-2012-00287 1 of 47

GOM Lithospan 2D Phase I
Project Location Map
GX Technology
Angelina, Hardin, Jefferson, Polk, and Tyler Counties, Texas

SWG-2012-00287

Map Produced by
Dixie Environmental Services Co., LP
February 29, 2012

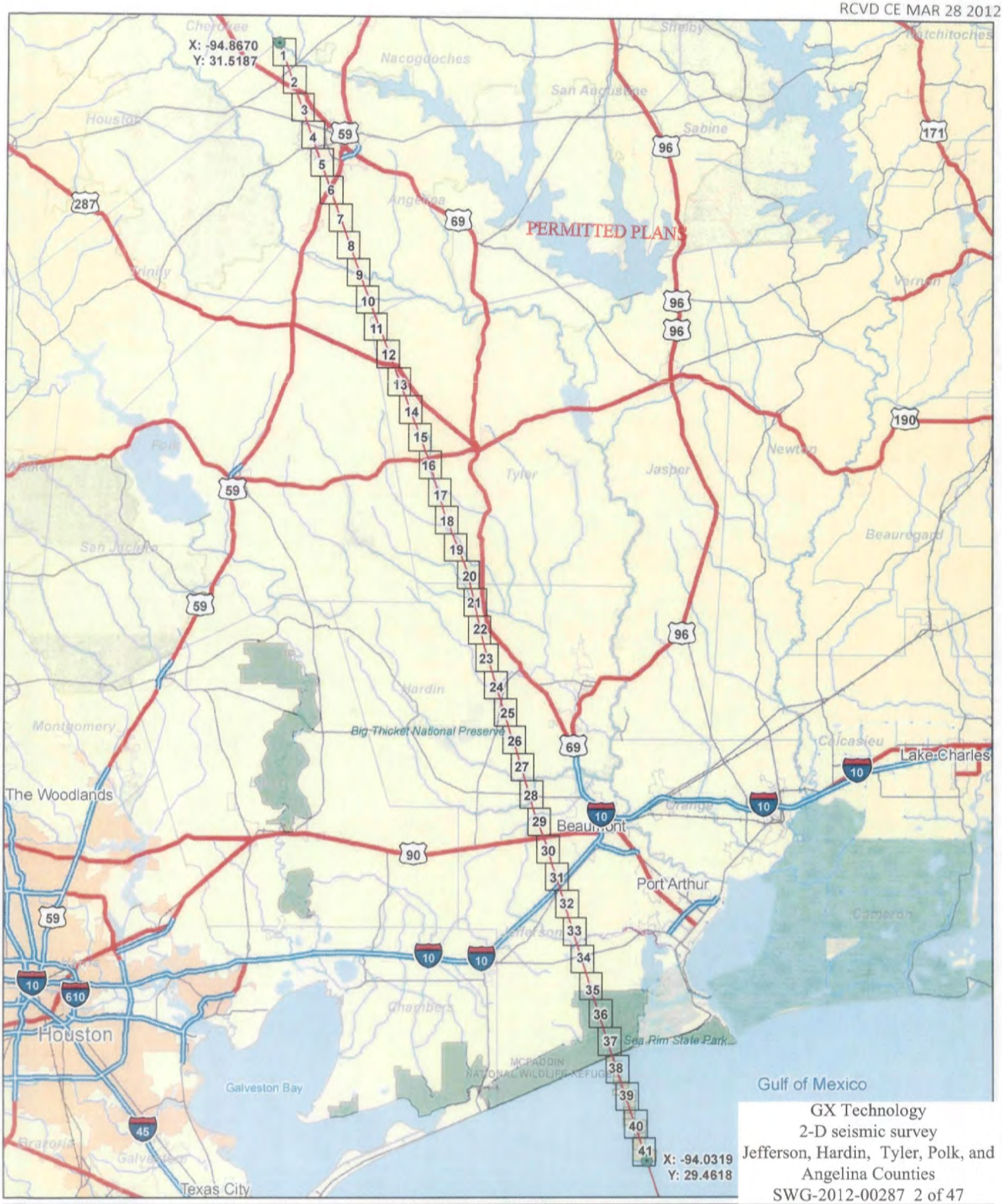
Map Datum: NAD 1927 UTM Z15N. Meter
Coordinates Displayed in Decimal Degrees
Map Base: ESRI USA Base Map

N

1:996,399

Legend
- Corner Coordinates
- Proposed GOM Lithospan Ph. I 2D Line
- State Submerged Lands (GLO) in GOM
- Taylor Bayou (GLO)

0 2.5 5 10 15 20 Miles



GX Technology
2-D seismic survey
Jefferson, Hardin, Tyler, Polk, and Angelina Counties
SWG-2012-00287 2 of 47

GOM Lithospan 2D Phase I
GX Technology
Angelina, Hardin, Jefferson, Polk, and Tyler Counties, Texas

Page Grid Map

Map Datum: NAD 1927 UTM Z15N, Meter
Coordinates Displayed in Decimal Degrees
Map Base: ESRI USA Base Map

Map Produced by
Dixie Environmental Services Co., LP
February 28, 2012

N
1:996,399

Legend
- Corner Coordinates
- Proposed GOM Lithospan Ph. I 2D Line
- State Submerged Lands (GLO) in GOM
- Taylor Bayou (GLO)

0 2.5 5 10 15 20 Miles

RAILROAD COMMISSION OF TEXAS

OIL AND GAS DIVISION

April 19, 2012

GX Technology
2150 City West Blvd Ste 900
Houston, TX 77042

Attn: Ray Wall ray.wall@iongeo.com

Re: Depth to protect usable-quality ground water for seismic shot holes
Seismic Line: Gulf of Mexico LithoSpan Phase I 2D
Counties: Jefferson, Hardin, Tyler, Polk, and Angelina

Dear Mr. Wall:

This letter is in response to your letter of 27 March 2012, requesting the base of usable-quality ground water in the captioned area involving the use of seismic shot holes. Pursuant to RRC Statewide Rule 100, effective 1 September 1992, this Agency offers the following recommendation for the protection of usable-quality ground water.

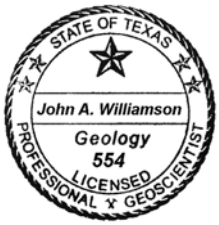
Usable-quality ground water occurs from the surface to the indicated depths along your provided survey path on the following numbered maps:

Map 1 2,300 feet to 825 feet (Angelina Co.)
Map 2 1,600 feet to 450 feet (Angelina, Polk, and Tyler Cos.)
Map 3 2,100 feet to 1,250 feet (Tyler and Hardin Cos.)
Map 4 2,400 feet to 1,600 feet (Hardin and Tyler Cos.)
Map 5 1,600 feet to 400 feet (Hardin and Jefferson Cos.)
Map 6 400 feet to 100 feet (Jefferson Co.)

South of abstract A-312 in Jefferson County, the base of usable-quality groundwater occurs at 100 feet, and in that area shot holes should not penetrate that depth. In the remainder of the survey, your 150-foot shot holes will not penetrate the base of usable-quality groundwater.

If you have any questions concerning this recommendation, please contact us at 512/463-2741.

Sincerely,



Mark R. Vining, P.G.
Geologist, Groundwater Advisory Unit

John A. Williamson, P.G.
Geologist, Groundwater Advisory Unit

MRV/JAW:eb
cc: RRC District Office

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TITLE 16	ECONOMIC REGULATION
PART 1	RAILROAD COMMISSION OF TEXAS
CHAPTER 3	OIL AND GAS DIVISION
RULE §3.100	**Seismic Holes and Core Holes**

(a) Definitions. The following words and terms, when used in this section, shall have the following meanings, unless the context clearly indicates otherwise.

(1) Seismic hole--Any hole drilled for the purpose of securing geophysical information to be used in the exploration or development of oil, gas, geothermal, or other mineral resources.

(2) Core hole--Any hole drilled for the purpose of securing geological information to be used in the exploration or development of oil, gas, geothermal, or other mineral resources, except coal or uranium. For regulations governing coal exploratory wells, see Chapter 12 of this title (relating to Coal Mining Regulations), and for regulations governing uranium exploratory wells, see Chapter 11, Subchapter C of this title (relating to Surface Mining and Reclamation Division, Substantive Rules--Uranium Mining).

(3) Project area--The geographic area in which an exploratory survey involving one or more seismic holes or core holes is carried out.

(4) Protection depth--Depth or depths at which usable quality water must be protected or isolated, as determined by the Groundwater Advisory Unit of the Oil and Gas Division.

(5) Operator--The person who contracts for the services of a seismic crew or core hole drilling contractor or, if the seismic survey or core hole testing is not performed on a contract basis, but is performed by an exploration and production company or by a geophysical contractor for speculative purposes, the person who drills the seismic holes or core holes.

(6) Commission--The Railroad Commission of Texas or its authorized representative.

(b) Exemption. Any seismic hole or core hole drilled to a depth of 20 feet or less is not subject to the requirements of this section.

(c) Determination of protection depth. Before drilling any seismic hole or core hole in a project area, an operator shall obtain a letter from the Groundwater Advisory Unit of the Oil and Gas Division stating the protection depth or depths in the project area.

(d) Drilling permits.

(1) Holes that do not penetrate any protection depth. A seismic hole or core hole that does not penetrate any protection depth does not require a drilling permit.

(2) Holes that penetrate any protection depth. A seismic hole or core hole that penetrates any protection depth requires a drilling permit to satisfy the requirements for exploratory wells described in §3.5(g) of this title (relating to Application To Drill, Deepen, Reenter, or Plug Back) (Statewide Rule 5).

(e) Plugging.

(1) Holes that do not penetrate any protection depth. A seismic hole or core hole that does not penetrate any protection depth must be plugged in accordance with subparagraph (A) or (B) of this paragraph. Seismic holes must

be plugged after the hole is loaded with explosives. Core holes must be plugged immediately after completion of coring the hole.

(A) The operator shall adequately plug the hole by filling it from total depth to a depth of no more than 16 feet below the surface with drill cuttings and/or bentonite. Immediately above the drill cuttings and/or bentonite, the operator shall place a bentonite plug no less than 10 feet in length. A plastic cap imprinted with the name of the operator shall be set above the bentonite plug no less than three feet below the surface. The remainder of the hole shall be filled with drill cuttings or native soil. All precautions should be taken to prevent bentonite from bridging over.

(B) Alternative plugging procedures and materials may be utilized when the operator has demonstrated to the commission's satisfaction that the alternatives will protect usable quality water.

(2) Holes that penetrate any protection depth. A seismic hole or core hole that penetrates any protection depth must be plugged in accordance with the requirements of §3.14 of this title (relating to Plugging) (Statewide Rule 14) and a plastic cap imprinted with the name of the operator shall be set in the hole no less than three feet below the surface.

(f) Physical requirements for bentonite plugging materials. Bentonite materials used to plug seismic or core holes shall be derived from naturally occurring, untreated, high swelling sodium bentonite that is composed of at least 85% montmorillonite clay and that meets the International Association of Geophysical Contractors (IAGC) recommended geophysical industry standard dated January 24, 1992, for the physical characteristics of bentonite used in seismic shot hole plugging.

(g) Reporting.

(1) Holes that do not penetrate any protection depth. Within 30 days of plugging the last hole in the project area, the operator shall submit a letter to the commission stating that each seismic hole or core hole in the project area has been plugged in accordance with subsection (e)(1) of this section. The letter must include the plugging date for each hole and the name and address of the operator. A plat of the project area identifying seismic or core hole locations, counties, survey lines, scale, and northerly direction must be attached. A United States Geological Survey map of the project area with hole locations marked will satisfy the plat requirement. In addition, a letter from the Groundwater Advisory Unit of the Oil and Gas Division stating the protection depth or depths must be attached.

(2) Holes that penetrate any protection depth. For any seismic or core hole that penetrates any protection depth, a plugging record shall be filed in accordance with §3.14 of this title (relating to Plugging) (Statewide Rule 14).

Source Note: The provisions of this §3.100 adopted to be effective September 1, 1992, 17 TexReg 5283; amended to be effective August 25, 2003, 28 TexReg 6816; amended to be effective July 2, 2012, 37 TexReg 4892

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